Egypt. J. Chem. **Vol. 65,** No. 3 pp. 191 - 201 (2022)

Egyptian Journal of Chemistry

http://ejchem.journals.ekb.eg/

Effect of Pilates Mat Exercise on Myoelectric Activity of Cervical Muscles in Patient with Chronic Mechanical Neck Pain: Randomized Clinical Trial

Mahmoud S Mahmoud*[a], Maher A El-Kablawy[b], Alshaymaa S Abd El-Azeim [c]

[a] Major of physiotherapy and rehabilitation specialist in the armed forces and head of the department of physiotherapy in El-Wafaa and El Amal hospital, Egypt

[b] Professor of Physical Therapy, Faculty of Physical Therapy, Cairo University, Egypt.

[c] Lecturer at Basic Science Department, Faculty of Physical Therapy, Cairo University, Egypt

Abstract

The goal of this study is to detect the efficacy of Pilates mat exercise and conventional therapy on cervical flexor and extensor myoelectric amplitude in subjects with chronic mechanical neck pain. This trial included 91 participants from both genders (42 males and 49 females) who were diagnosed by an orthopedist with chronic mechanical neck pain and referred to the physiotherapy clinic. The participants were randomly assigned to two groups: Group A, which is an experimental group, included those receiving Pilates mat exercise in conjunction with conventional therapy, and Group B, which is a control group, included those receiving only conventional therapy. The intervention was delivered to both groups three times a week for 12 weeks. In this study, the variables pain, function, and muscle activity were measured using the visual analogue scale, Arabic neck disability index, and Electromyography respectively. All variables were assessed before and after the 12 weeks. To detect the impact of treatment and time on all measured variables, mixed ANOVA was used and showed a statistically significant effect ($p < 0.05$) in both groups in treatment and time with favor to Pilate's group. Pilates mat exercise combined with conventional therapy and conventional therapy alone are effective techniques for refining neck pain, function, and muscle amplitude in subjects with chronic mechanical neck pain, with further advantages shown in the experimental group that received the Pilates mat exercise treatment.

Key Terms: Cervical Muscles; Mechanical Neck Pain; Pilates Mat Exercise; Myoelectric Amplitude.

1. Introduction

Neck pain is one of the most common situations that affect about 70% of individual at different stages in their lives **(1, 2)**. According to worldwide epidemiological reports the incidence of neck pain is around 40% varying from 17% to 75% **(3)**. When individuals have neck pain without a specific pathoanatomic origin, they are commonly classified as having mechanical neck pain **(4)** and About 50%-80 % of individuals involving back or neck pain do not definitively identify an underlying pathology**(5)**.Usually, mechanical neck pain occurs insidiously **(6)** and is typically of multifactorial origin involving one or more of the following causes: pressure of the neck, poor posture, anxiety, depression and occupational activities **(7)**.The high incidence of Neck Pain has an important economic influence on health care providers**(3)**owing to the huge prevalence and severe effects of neck pain in human life. the diagnosis and treatment remained an issue until now **(8, 9)**.

In normal cervical spine mobility and stability neck muscles play an important role. Often the cause of pain may be the cervical muscles, there are Studies suggests that neck fatigue or exhaustion may be related to neck pain. **(10-13)**. the stabilization model of Panjabi shows that approximately 80% of spinal stability is dependent on muscle activity **(14)**. Flexor and extensor cervical spine muscles are like a sleeve that surrounds the vertebrae at posterior and anterior side **(15)**. For patients with neck pain deep cervical flexors (DCF) and spine extensors (deep and superficial) deterioration is commonly documented **(16)** In addition, Various neuromuscular dysfunctions are often involved in neck pain including decreased

*Corresponding author e-mail: mahmoudharidy88@gmail.com; (Mahmoud S. Mahmoud).

EJCHEM use only: Receive Date: 23 August 2021, Revise Date: 03 September 2021, Accept Date: 05 September 2021

DOI: 10.21608/ejchem.2021.92268.4371

deep flexor function, increased superficial Sternocleidomastoid (SCM) muscle activity and co-contraction of extensors and flexors (rather than co-ordination) have developed in neck pain [16]

The studies mentioned indicates that Anterior Scalene (AS) and SCM have increased electromyography amplitude as superficial flexors and declining EMG amplitude of DCF muscles including longus capitis and longus colli [15,17] . **Gras et al (2018)** also reported that the amplitude of SCM, Upper trapezius (UT), cervical extensors and anterior scalene muscles have been dramatically increased among patients suffering from neck pain [18]**.**

The techniques of physiotherapy for mechanical neck pain usually includes neck muscles stretching and strengthening exercises[19], cervical stabilization and mobilization exercises, thrust manipulation of the thoracic spine, kinesio-taping technique [20] ischemic compression on trigger points [21-23]and electrotherapy [24] .Comprehensive program known as the Pilates method were developed by Joseph H. Pilates in the 1920's [4] . Pilates is another common type of mind-body exercises that focuses on posture , respiration and coordinated movement. It is a body conditioning system that enhances balance, posture, muscle tone, coordination and flexibility through exercises that stretch out and strengthen selective muscles [25]. Pilate's workouts have been used to improve neck muscles through exercises that increase strength and stability of the muscles. Pilates working on strength the internal (local) muscles of the neck and ensure the large outer (global) muscles are not being used as a compensation to support your head [4, 25, 26]. The effectiveness of the Pilates exercise on pain and function has been investigated by numerous literature reports. [25, 27, 28, 29] however, no studies have been performed to examine its efficacy on cervical flexor and extensors myoelectric amplitude during functional position so this experiment had been inducted.

Material and methods:

Study design

Double blinded randomized clinical trial was carried out in compliance with the 1964 Helsinki Declaration and its subsequent modifications and the guidelines of Consolidated Standards of Reporting Trials [30]. This trial approved by the research ethics committee of the physical therapy college at Cairo University (P.T.REC/012/002837). It was registered at Pan African Clinical Trial (PACTR202007880609645). Before engaging in the study, each patient received their voluntary and written informed consent. This trial conducted from September to the end of December 2020.

Participants

One hundred and ten participants assessed for eligibility but five participants didn't have the research criteria and another five participants refused to participate as shown in figure **(1).** One hundred participants allocated randomly to two groups but nine participants don't receive any treatment due to the widespread of COVID 19 and some others were busy. Ninety one patients from both genders (42 males and 49 females) completed this trial. Their ages between 20 and 35 years and referred to physical therapy by an orthopaedist with a diagnosis of mechanical neck pain at the outpatient clinic of the Faculty of Physical Therapy, Cairo University. They were all either students or office workers. They received a standardized physical assessment by an assessor blinded to their allocation [31 , 32]**.** The patient's inclusions criteria include: (1) patients who suffer from pain for more than 3 months, (2) severity of pain between 3 cm and 8 cm in a pain numerical rating scale [33] Moreover; (3) a score above 15 on the Arabic Neck Disability Index suggests the existence of at least moderate neck pain disorder [31] . The exclusion criteria of this trial includes patients were (1) diagnosed with fibromyalgia, (2) radiating neck pain into the upper limbs, (3) spine trauma, (4) spine infection (5) physical exercise begun or modified through the last three months, (6) Patients who had visual impairments (7) those with Musculoskeletal disorders that prevent Pilates exercise [27] .

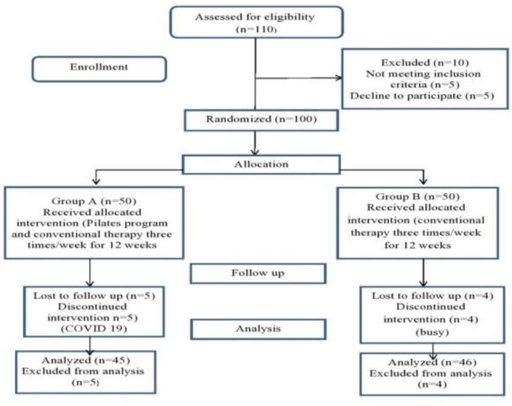

Figure (1): Consort Flow Diagram

Sample size: calculation the numbers of patients in this trial depending on pilot study from 20 patients with mechanical neck pain. The patients assigned randomly to two groups; one group received Pilates and conventional therapy and the other group received conventional therapy alone. The primary dependent measure was pain intensity and its effect size was 0.63. Alpha level was set on 0.05 and power level on 80%. The estimated total sample size was 82 subjects; 41 subjects within each group. G power (3 . 1. 9. 2) Was used for calculation

Dependent Variables:

The primary dependent variable for this study was neck pain intensity measured by the Numerical Pain Rating Scale (NPRS), cervical flexor (SCM and anterior scalene muscles (AS)) and cervical extensor (upper trapezius (UT) and splenius capitius (SC) muscles) EMG characteristics in the form of normalized RMS that reflects muscle amplitude. The NPRS (range; 0 represented no pain and 10 represented maximum pain) is a reliable and valid tool for assessment of pain [34]. The NPRS has 1.3 minimal detectable change and 2.1 points for minimal clinically important difference [35].

The secondary dependent measure was Arabic neck disability index (ANDI). It is a valid and reliable tool consisting of 10 items with six choices (0–5) [36]. Each subject was requested to choose the best choice for his/her case. Then, the numbers were collected and the level of disability was detected. There is no disability for scores from 0 to 5; 5–14 is mild; 15–24 is moderate; 25–34 is severe, and finally, more than 34 is a complete disability [37].

Assessment of Muscles amplitude (RMS)

The equipment of MyoSystem 1400A was used for assessment of normalized RMS of cervical flexor and extensor muscles. Electrode placement sites were shaved and washed with a piece of cotton rinsed with alcohol to minimize skin impedance. Electrodes on both sides were located as follows: The monitoring electrodes were positioned for SCM as follows: around 1/3rd of the length rostral to sternal attachment, Over belly muscle [38] , AS: parallel to the lateral border of the clavicular component of SCM in the direction of the muscle fibers [39] , UT: 2 cm lateral to the center of a line from C7 spinal process and the posterolateral acromion [40] and SC: 6–8 cm lateral to the spine of C4 (almost 3 cm inferior to mastoid process) [38]. The ground electrode was positioned over the spinous process of C7 [40].

The raw EMG was amplified (bandwidth = 20-450 Hz, typical mode rejection ratio >80 DB at 60 Hz, input impedance = 10 GΩ) and obtained with a range of ± 2.5 V range. The EMG signals of systemic bias were eliminated and full wave was rectified before filtering. The resulting linear envelope signals were then normalized to maximal voluntary isometric contractions (MVICs).

Normalization of EMG data

the participants were asked to elevate his/her head from supine lying position while the physiotherapist hold it isometrically for assessment of MVICs of SCM and AS [39, 41] **(figure 2,3).**

Figure 2: SCM muscle recording

figure 3: AS muscle recording

For UT the arm was abducted at 90° from sitting position and proximal resistance was provided to the elbow joint [40] and finally for the SC, in a prone lying position, the participant was asked to elevate the head 20 mm while the physiotherapist hold it isometrically [38] **(figure 4,5).**

Figure 4: UT muscle recording

figure 5: SC muscle recording

Isometric contraction was applied three times with each contraction being sustained for 7 seconds and with a 30-second rest between contractions [42]

Assessment of Muscle Activity

After the evaluation of the MVICs, patients were told to write for 15 minute (all of participants write in Arabic and the same words) while sitting, this task was selected because it is the most common everyday task for participants and requires a semi-static load that aggravates their symptoms. During the assessment, the position of the head, neck, shoulder and spine had been standardized to avoid having an impact on the movements of the examined muscles. The patients were advised to sit naturally on a flat, horizontal wooden chair with a backrest. The chair height has been calibrated to guarantee that the participant thighs were horizontal, parallel to the surface and their feet are placed at the width of the shoulder and are well balanced. Normalized RMS% was calculated [(EMG amplitude during writing task / average of the 3 trials of MVIC) *100] [43].

Randomization and blinding:

Dependent variables were assessed at baseline and 12 weeks by an assessor blinded to the treatment allocation. Patients were blinded to their therapy allocation and uninformed of what intervention the other group would receive. Each patient was instructed to don't take with other patients in treatments. Patients were randomly selected to undergo Pilates mat exercise and conventional therapy (experimental group) or conventional therapy only (control group). The concealed distribution was carried out using a computer-generated randomized table of numbers developed by a researcher who was not participated in either selecting or handling patients prior to the start of data collection. Individually, sequentially numbered index cards were folded and inserted into sealed, opaque envelopes containing the randomly selected intervention group. Blinded to the baseline test results, a second therapist opened the envelope and started the therapy according to the group assignment. The intervention was given to all patients on the day of the initial examination.

Treatments:

Control group: Patients received exercises in this category that included active ROM exercises in the neck, isometric exercises in the neck [44, 45] , chin in , scapular retraction, ROM shoulder, neck extensors and pectoral stretching, 10 minutes of moist heat (hot pack). Precaution and ergonomic advice [46] the participants were given these activities as home programs.

Dosage: 5 set of exercises × 10 repetitions with 2 min rest between each set for 12 weeks.

Experimental group: Patients undergoing Pilates and conventional therapy subjects were independently evaluated and taught the five main elements of Pilates [25].

Beginner exercises:

Hip twist level 1: Active starting position: one knee shifts away from and then towards the midline of the body while keeping a neutral spine position. This challenges the rotational function of the lumbar spine **(figure 6).**

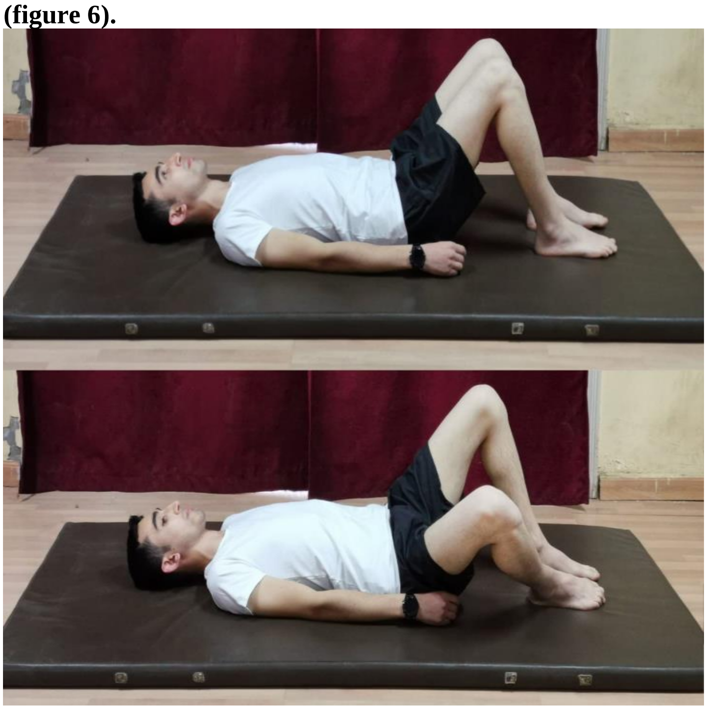

Figure 6: hip twist level 1

Double leg stretch level 1: The arms are both lowered overhead while retaining ribcage and pelvic control **(figure 7).**

Figure 7: Double leg stretch level 1

Double leg stretch level 2: As for level 1 but at the same time pushing one heel away from the body along the mat **(figure 8).**

Figure 8: Double leg stretch level 2

One leg stretch level 1: One heel pushes down against the mat, stretching the same leg without causing the pelvis to tilt anteriorly **(figure 9).**

Figure 9: **One leg stretch level 1**

Clam level 1: starting position: Side lying, knees bent to 90 degrees, open the upper knee towards the ceiling, keeping contact with the medial sides of the legs with the hips stacked **(figure 10).**

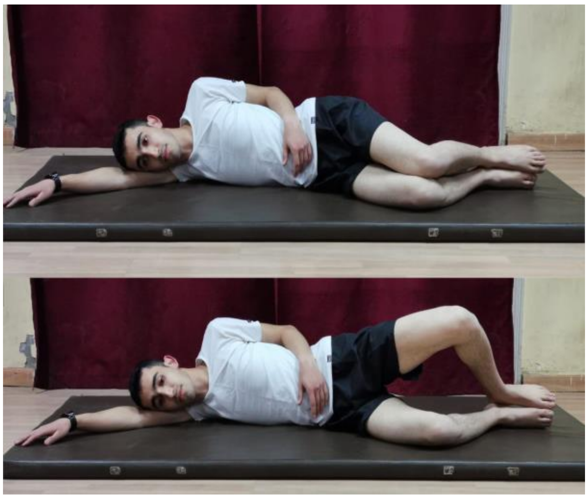

Figure 10: Clam level 1

Shoulder bridge level 1: Starting position: crook lying, inhaling and during exhalation spine up the vertebra leading from the coccyx to the shoulder blades **(figure 11).**

Figure 11: Shoulder bridge level 1

Scissors level 1: starting position: supine, one knee is raised over the hip (with a 90 degrees angle at the knee and hip) while the pelvis remain neutral **(figure 12).**

Figure 12: Scissors level 1

Arm opening level 1: The uppermost arm is raised out of the body to open the upper chest and rotate the thoracic and lumbar spine **(figure 13).**

Figure 13: Arm opening level 1

Breast stroke prep level 1: starting position: prone, the shoulder blade glides softly downwards away from the ears as the arms are raised up 4-5 cm from the mat **(figure 14).**

Figure 14: Breast stroke prep level 1

Breast stroke prep level 2: As for level1, the upper body was lengthened from the mat to hover 3 cm of the breastbone from the floor while retaining a neutral lumbo-pelvic position. Keep the neck back long **(figure 15).** This exercise retains the co-activation of upper, lower trapezius, deep and serratus anterior, neck flexors and extensors [(25)].

Figure 15: Breast stroke prep level 2

Dosage: Each session lasted one hour and started with a warm-up of ten minutes and ended with a cool-down of 5-10 minutes 3 days a week for 12 weeks.

Statistical Analysis:

Patient's data was subjected to Shapiro–Wilk test to determine its normality. All of the data (age, weight, height, body mass index (BMI), VAS, ANDI, and RMS of SCM, AS, UT and SC) were normally distributed. Thus, at physical characteristics (age, weight, height, and BMI) analysis parametric *T*-test was used to detect the differences between experimental and control group). Dependent variables were analyzed by mixed model multivariate analysis of variance (MANOVA) detect the differences between time and treatments at all variables between subjects of both groups. Chi square test used for assessment the difference between both groups at gender distribution. SPSS version 23 (IBM Corp, New York, United States) was used and α =0.05.

Results of the Trial

The Physical Characteristics of Subjects:

An unpaired *T*-test was used to decide the changes between the two groups in terms of age, weight, height and BMI and revealed no statistically significant difference was found between groups **(Table 1)**.

Table 1: Physical characteristics of subjects

	Pilates group Mean ± SD	**Conventional group Mean ± SD**	**T-value**	**P-value**
Age (years)	20.85 ± 2.47	22.1 ± 3.11	−1.41	0.17 [a]
Weight (kg)	68.35 ± 8.32	65 ± 5.79	1.100	0.28 [a]
Height (cm)	165.75 ± 7.42	168.50 ± 8.67	−0.48	0.63 [a]
BMI (kg/m ^{2})	24.06 ± 3.57	22.96 ± 4.22	0.88	0.38 [a]
Gender (males/females)	22 males/23 females	20 males/26 females	X^2=0.26	0.6

[a]: no significant difference between two groups; SD: standard deviation; *p*-value: significance level; BMI: body mass index; X^2: chi square.

Results of dependent variables:

MANOVA was conducted to detect the effect of treatment on all dependent variables in general, and it was found that there were significant effects of treatment as p = 0.0001 and f = 18.3 and time as p = 0.0001 and f = 353.61. Moreover, for interaction between time and treatment, there was a significant interaction as p = 0.0001 and f = 22.57 Multiple pairwise comparison within groups exposed that there was a significant difference in all variables in both groups as $p < 0.05$ with more benefits in all variables in Pilates group **(Table 2,3,4).**. Partial Eta Square was used to detect the size of difference between the groups at post treatment and the size was found to be medium and large after the treatment ($\eta 2$ > 0.06). Partial Eta Square: effect size (small >0.01, medium >0.06, large>0.14).

Results of VAS and ANDI

Inter-group analysis at pre-treatment, there was no significant difference as *p* = 0.48. intra-group analysis; there was a significant decrease in pain level after 12 weeks in both groups with favor to Pilates group as shown in **table (2)** also, Partial Eta Squared at post-treatment revealed a significant difference between both groups as $\eta 2$ = 0.84. In ANDI variable there was no significant difference at pre-treatment as *p* = 0.5. Intra-group there was a significant decrease in level of disability in both groups with favor to Pilates group and $\eta 2$= 0.74 at post-treatment**.**

Table 2: Results of NPRS and ANDI within groups

Dependent variables		Pre-treatment Mean and SD	Post-treatment Mean and SD	p-value within	% of change	95% Confidence interval
NPRS	Pilates G	6.4±1.78	1.2±0.44	0.0001 [b]	81%	4.41 to 5.98
	Conventional G	6.75±1.29	5.2±0.83	0.001 [b]	23%	0.76 to 2.33
ANDI	Pilates G	24.85±3.04	8.85±1.13	0.0001 [b]	64%	14.65 to 17.34
	Conventional G	25.4±1.98	13.75±1.77	0.001 [b]	46%	10.31 to 12.99

NPRS:numerical pain rating scale; ANDI: Arabic neck disability index; SD: standard deviation; b: significance difference; G: group; %: percent

Results of normalized root mean square at cervical flexors muscles two-sided

For SCM and AS muscle RMS; the results reported that there was no significant difference at pre-treatment (RT and left side) in inter-group analysis as *p* = 0.78 (RT/SCM), 0.48(LT/SCM), 0.76 (RT/AS) and 0.34 (LT/AS) respectively. Intra-group analysis; there was a significant decrease in normalized RMS value at both sided of both groups with favor to Pilates group **(table 3).** Partial Eta Squared at post-treatment revealed a significant difference between both groups as $\eta 2$ = 0.58 (RT/SCM), 0.54(LT/SCM), 0.36 (RT/AS) and 0.54 (LT/AS).

Table 3: Results of cervical flexors RMS

Dependent variables (RMS)		Pre-treatment Mean and SD	Post-treatment Mean and SD	p-value (within)	% of change	95% Confidence interval
RT/SCM	Pilates G	15.53±1.63	8.52±1.45	0.001 [b]	45%	6.02 to 7.99
	Conventional G	15.39±1.68	11.79±1.36	0.001 [b]	23%	2.61 to 4.58
LT/SCM	Pilates G	15.71±2	8.12±1.35	0.001 [b]	48%	6.1 to 8.26
	Conventional G	15.31±1.49	11.51±1.43	0.001 [b]	25%	2.73 to 7.89
RT/AS	Pilates G	14.19±1.47	8.83±1.18	0.001 [b]	38%	4.51 to 6.21
	Conventional G	14.33±1.42	10.82±1.49	0.001 [b]	24%	2.66 to 4.35
LT/AS	Pilates G	13.9±1.33	7.48±1.18	0.001 [b]	46%	4.39 to 6.44
	Conventional G	13.37±2.08	11.26±1.45	0.001 [b]	16%	1.08 to 3.13

RMS: Root mean square; RT: right; LT: left; SCM: sternocleidomastoid; AS anterior scalene; *p*-value: probability; [b]: significance difference; SD: standard deviation; G: group; %: percent

Results of normalized root mean square at cervical extensor muscles two-sided

Finally, cervical UT and SC have significant decrease in value of RMS at both sides with favor to Pilates group **(table 4).** Inter-group analysis at pre-treatment, there were no significant difference as *p* = 0.06 (RT/UT), 0.65 (LT/UT), 0.81 (RT/SC) and 0.69 (LT/SC) respectively. Partial Eta Squared at post-treatment revealed a significant difference between both groups as $\eta 2$ = 0.64 (RT/UT), 0.55(LT/UT), 0.55 (RT/SC) and 0.58 (LT/SC).

Table 4: Results of cervical extensor RMS

Dependent variables (RMS)		Pre-treatment Mean and SD	Post-treatment Mean and SD	p-value (within)	% of change	95% Confidence interval
RT/UT	Pilates G	13.99±1.32	8.52±1.24	0.001 [b]	39 %	4.65 to 6.28
	Conventional G	14.85±1.53	12±1.32	0.001 [b]	19 %	2.15 to 3.81
LT/UT	Pilates G	15±1.36	7.89±1.65	0.001 [b]	47 %	5.76 to 7.67
	Conventional G	15.15±1.37	11.6±1.45	0.001 [b]	23 %	2.59 to 4.5
RT/SC	Pilates G	14.48±1.45	7.52±1.39	0.001 [b]	48 %	5.32 to 6.97
	Conventional G	14.59±1.49	10.9±0.99	0.001 [b]	25 %	2.87 to 4.51
LT/SC	Pilates G	15.02±1.59	8.54±1.13	0.001 [b]	43 %	5.81 to 7.15
	Conventional G	15.18±1.11	11.01±1.63	0.001 [b]	27 %	3.49 to 4.83

RMS: Root mean square; RT: right; LT: left; UT: upper trapezius; SC: splenius capitis; *p*-value: probability; [b]: significance difference ; G: group; %: percent

Discussion

This trial was designed to detect the efficacies of adding Pilates to conventional therapy on cervical flexor and extensor muscles amplitude in patients with mechanical neck pain. The results reported refinement in pain intensity at both groups; Pilates group had decrease in pain level by 81% and in conventional group by 23%, also in disability level there was a significant decrease in Pilates by 64 % and in control group by 46%. Finally, muscle amplitude was measured in the form of normalized RMS of both superficial flexors and extensors muscles and decreased in both groups with favor to Pilate's group.

For clarification of these results; there are a variety of hypotheses that confident the neck pain is regularly associated with defensive spasm in the muscles around the neck that causes muscle pressure leading to the development of ischemia which in turn lead to more pain. Particularly since our patients were either office workers or students, they were typically following a persistent non-neutral posture. By alleviating pain and muscle spasm this vicious cycle "which can take place in reverse" may be disrupted [47, 48].

In addition, Pain is correlated with changed the pattern of muscle recruitment; the high intensity of muscle tension and tone reduces muscle length and induces excessive muscle imbalances and therefore increased discomfort and pain [49]. In this study, the Pilates approach is centered on developing and improving systematic balances rather than individual ones (cervical or thoracic) regions, which support core stability and spinal segmentation and separation. In addition, Decreased tension in shortened and impaired muscles during the workout are considered of the additional advantages of Pilates exercise [50]; enhanced methodologies for the respiration of the ribs and diaphragm (diaphragmatic and rib breathing) that boost core stability; and enhanced understanding of abnormalities in the posture [28].

The findings of this study demonstrate that adding of Pilates to conventional therapy results in improvement of muscle amplitude. In addition, reducing neck pain and enhancing neck function [45]. There are studies that investigate the effect of Pilates solely [25, 27] or in comparison to other therapy strategies [27/29] for mechanical neck pain patients. However, the role of Pilates and conventional therapy together in reducing pain and dysfunction level is confirmed by only one study. **Nandita et al., (2018)** reported the effectiveness of Pilates and conventional therapy in patients with mechanical neck pain and showed improvement in neck pain and function in all groups with a better outcome in the group who used Pilate's workouts [28].

Our study has shown that the AS, SCM, SC and UT activity levels decreased dramatically in the Pilates group. Previous studies on neck pain have found distorted activity pattern for neck muscles, described as increased superficial muscles activity and decreased activity of deep muscles during functional and cognitive tasks [16]. Furthermore, Panjabi stated that the muscles provided about 80% of spinal stabilization [14]. In stabilization, there is a different function for deep and superficial muscles. Deep muscles are segmental stabilizers, so stability between segments must be provided which is important as a basis for superficial muscle participation [51]. DCF weakness reported in neck pain may lead to an increased level of superficial flexor muscle activity [51]. Pilates exercise working on strengthening the neck DCF and ensuring that large outer (global) muscles are not used to support your head [4]. Furthermore, the activity of superficial flexor and extensor was inhibited due to reduction in the tension of weak muscles [50].

Improvements in pain, function and muscle activity were documented also in conventional therapy group. The cumulative impact of postural adjustment exercise (chin-in, scapular retraction exercise and ergonomic advice), isometric exercise, cervical extensor stretching and moist heat exercise can be due to this refinement. Postural exercises may have two main benefits. First, it can regularly decrease the adverse loads caused by poor cervical and scapular postures on the cervical joints. Second, in its supporting role, it trains the deep postural stabilizing muscles of the spine. A change in postural patterns will occur if these exercises are carried out repeatedly during the day [52].

We suggest the influence of neutral postural awareness that relieves pain-causing tension. Our findings align with those of Mclean, who found effects on cervical muscles from posture correction exercises [40]. Due to neck retractions, Abd El-wahab and Sabbahi showed H reflex amplitude alteration and they were recommended to be used for C7 radiculopathy [53]**.** Enhancement in the control group may be because of the rapid hypoalgesic effects of isometric exercises along with stretching exercises, which is generally compatible with the suggested mechanism of action of isometric exercise. These exercises are used to treat somatic dysfunction resulting cervical pain [54].

Limitation: This trial has many important limitations that need to be considered in future research; no follow up to investigate the long term effect of treatment, the other limitation was no assessment of deep cervical flexor muscle amplitude which imported for assure the effectiveness of treatment program.

4. Conclusion: Pilates exercise and conventional therapy are an effective method for inhibit pain, disability, muscle activity. Conventional therapy alone is effective method of treatment but needed to combine it with other model of exercise such as Pilates. In addition, the patient with mechanical neck pain need to home program in the form of postural corrections exercise and ergonomic modifications.

Conflict of Interest: The authors declare that there is no conflict of interest.

Sources of Funding: This trial did not obtain any particular awards in the state, private, or non-profit sector or from funding agencies.

References:

1. Cagnie B, Danneels L, Van-Tiggelen D. Individual and work related risk factors for neck pain among office workers: a cross sectional study. Eur Spine J 2007; 16(5):679-86.

2. Falla D, O'Leary S, Farina D, Jull G. The change in deep cervical flexor activity after training is associated with the degree of pain reduction in patients with chronic neck pain. Clin J Pain. 2012; 28(7)628-34.
3. Fejer R, Kyvik K, Hartvigsen J. The prevalence of neck pain in the world population: asystematic critical review of the literature. Eur Spine J. 2006; 15:834-48.
4. Heintz MM, Hegedus EJ. Multimodal management of mechanical neck pain using a treatment based classification system. J Man Manip Ther. 2008;16(7):217-24.
5. Hush JM, Maher CG, Refshauge KM. Risk factors for neck pain in office workers: A prospective study. BMC Musculoskelet Disord, 2006; 7:81.
6. Clair DA, Edmondston SJ, Allison GT. Physical therapy treatment dose for nontraumatic neck pain: A comparison between 2 patient groups. J Orthop Sports Phys Ther, 2006;36 (11): 867–875.
7. Hidalgo B, Hall T, Bossert J, Dugeny A, Cagnie B, Pitance L. The efficacy of manual therapy and exercise for treating non-specific neck pain: A systematic review. J Back musculoskelet rehabil, 2017; 30(6): 1149-1169.
8. Aker PD, Gross AR, Goldsmith CH and Peloso P. Conservative management of mechanical neck pain: systematic overview and meta-analysis. BMJ 1996; 313(7068): 1291-6
9. Kjellman GV, Skargren EI, Oberg BE. A critical analysis of randomised clinical trials on neck pain and treatment efficacy. A review of the literature. Scand J Rehabil Med, 1999; 31(3): 139-52.
10. Kristjansson E., Jonsson H. Is the sagittal configuration of the cervical spine changed in women with chronic whiplash syndrome? A comparative computer-assisted radiographic as- sessment. J Manipulative Physiol Ther 2002; 25(9): 550-5.
11. Silverman JL, Rodriquez AA, Agre JC. Quantitative cervical flexor strength in healthy subjects and in subjects with mechanical neck pain. Arch Phys Med Rehabil 1991; 72(9): 679-81.
12. Kristjansson E, Leivseth G, Brinckmann P, Frobin W. Increased sagittal plane segmental motion in the lower cervical spine in women with chronic whiplash-associated disorders, grades I–II: A case-control study using a new measurement protocol. Spine 2003; 28(19): 2215-21.
13. Hides JA, Richardson CA, Jull GA. Multifidus muscle re- covery is not automatic after resolution of acute, first-episode low back pain. Spine 1996; 21(23): 2763-9.
14. Panjabi MM. The stabilizing system of the spine. Part II. Neutral zone and instability hypothesis. J Spinal Disord. 1992; 5(4): 390-396.
15. Mayoux-Benhamou MA, Revel M, Vallee C. Selective electromyography of dorsal neck muscles in humans. Exp Brain Res 1997; 113(2): 353-60.
16. Falla D, Jull G, Hodges PW. Feed forward activity of the cervical flexor muscles during voluntary arm movements is delayed in chronic neck pain. Exp Brain Res 2004; 157(1): 43-8.
17. Rezasoltani A, Ylinen J, Vihko V. Isometric cervical extension force and dimensions of semispinalis capitis muscle. J Rehabil Res Dev 2002; 39(3): 423-8.
18. Grase M O, RezkAllah S S, Abdelsattar M H, Elhafez H M. Inter-relationships Between Cervical Angles, Muscle Activity Levels and Mechanical Neck Pain. J Med Sci.2018;18(1): 11-19.
19. Ylinenet J, Takala EP, Nykänen M, Häkkinen A, Mälkiä E. Active neck muscle training in the treatment of chronic neck pain in women: A randomized controlled trail. JAMA , 2003; 289(19): 2509-2516.
20. Kilinc HE, Harput G, Baltaci G. Additional effects of kinesiotaping to mobilization techniques in chronic mechanical neck pain. Turk J Physiother Rehabil, 2015; 26(3): 107-113.
21. Damgaard P, Bartels EM, Inge R, Christensen R, Juul-Kristensen B. Evidence of physiotherapy interventions for patients with chronic neck pain: A systematic review of randomized controlled trails. ISRN Pain, 2013; Article ID 567175, p: 23.
22. Childs J, Cleland JA, Elliott JM, Teyhen DS, Wainner RS. Neck pain: Clinical practice guidelines linked to the international classification of functioning, disability and health from the orthopedic section of the American physical therapy association. J Ortho Sports. Phys Ther, 2008; 38(9): 1-34.
23. Vemon H, Humphreys K, Hagino C. Chronic mechanical neck pain in adults treated by manual therapy: A systemic review of changes score in randomized controlled trials of a single session. J Man Manip Ther,2007; 16 (2): E42-E52.
24. Jorge P, Armijo Olivo S, Magee DJ, Gross DP. Effectiveness of interferential therapy in the management of musculoskeletal pain: A systemic review and meta-analysis a research report. Phys Ther, 2010; 90(9): 1219-1238.
25. Mallin G, Murphy S. Effectiveness of 6 weeks Pilates programed on outcome measures in a population of chronic neck pain patients: A pilot study. J Bodyw Mov Ther, 2013; 17(3): 376-384.
26. Susan S, Stilp S, Akuthota V. yoga and Pilates in the management of low back pain. Curr Rev Musculoskelet Med, 2008; 1(1): 39-47.
27. Cazotti LA, Jones A, Silva DR, Ribeiro LH and Natour J. Effectiveness of the pliates method in the treatment of chronic mechanical neck pain: A

Randomized controlled trial. Arch phys med Rehabil. 2018; 15 (1):220-227.
28. Nandita E, Praveen D, Asif Hussain KS. Effectiveness of Pilates as an Adjunct to Conventional Therapy in Chronic Mechanical Neck Pain: A Randomized Controlled Trial. J Nov Physiother ,2018;8(1): 381.
29. Uluğ N, Yilmaz OT, Kara M, Özçakar L. effects of pilates and yoga in patients with chronic neck pain: a sonographer study. J Rehabil Med 2018; 50(1): 80–85.
30. Schulz KF, Altman DG, Moher D, CONSORT Group. CONSORT 2010 statement: updated guidelines for reporting parallel group randomized trials. BMJ. 2010;340:c332.
31. Vernon H. The Neck Disability Index: state-of-the-art, 1991-2008. J Manipulative Physiol Ther. 2008; 31(7):491-502.
32. Nordin M, Carragee EJ, Hogg-Johnson S. Assessment of neck pain and its associated disorders: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain andIts Associated Disorders. J Manipulative Physiol Ther .2009; 32(2 suppl):S117-S140.
33. Guzman J, Hurwitz EL, Carroll LJ. A new conceptual model of neck pain-linking onset, course, and care: the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. Spine (Phila Pa 1976) 2008;33(4 Suppl):S14-23.
34. Kumar P, Tripathi L. Challenges in pain assessment: painintensity scales. Indian J Pain. 2014;28(2):61-70.
35. Cleland JA, Childs JD, Whitman JM. Psychometric properties of the Neck Disability Index and numeric pain rating scale in patients with mechanical neck pain. Arch Phys Med Rehabil. 2008;89(1):69-74.
36. Shaheen AM, Omar MT, Vernon H. Cross-cultur-al Adaptation, Reliability, and Validity of the Arabic Version of Neck Disability Index in Patients with Neck Pain. Pain. 2013; 38(10): 609-615
37. MacDermid JC, Walton DM, Avery S, Blanchard A, Etruw E, McAlpine C, et al. Measurement properties of the neck disability index: a systematic review. J Or- thop Sports Phys Ther. 2009; 39(5): 400–417.
38. Sommerich CM, Joines SM, Hermans V and Moon SD. Use of surface electromyography to estimate neck muscle activity. J Electromyogr Kinesiol. 2000; 10(6): 377-98.
39. Falla D, Dall'Alba P, Rainoldi A,Merletti R and Jull G. Location of innervation zones of sternocleidomastoid and scalene muscles – a basis for clinical and research electromyography applications. Clin Neurophysiol 2002; 113(1): 57-63.
40. McLean L. The effect of postural correction on muscle activation amplitudes recorded from the cervicobrachial region. J. Electromyogr Kinesiol. 2005; 215(6):527-35.
41. Johnston V, Jull G, Darnell R, Jimmieson N, Souvlis T. Alterations in cervical muscle activity in functional and stressful tasks in female office workers with neck pain. Eur J Appl Physiol. 2008;103(3), 253-264
42. Larsson B, Karlsson S, Eriksson M, Gerdle B. Test–retest reliability of EMG and peak torque during repetitive maximum concentric knee extensions. J. Electromyogr. Kinesiol. 2003; 13(3):281-7.
43. Nicoletti C, Spengler C, Läubli T. Physical workload, trapezius muscle activity, and neck pain in nurses'night and day shifts: A physiological evaluation. Appl Ergon 2014: 45(3):741-623.
44. Petric PK, Ylinen JJ, Mälkiä EA, Kautiainen H, Häkkinen AH. Isometric strength of the cervical flexor, extensor and rotator muscles in 220 health females aged 20 to 59 years. J Orthop Sports Phys Ther.2006; 36 (7): 495-502.
45. Griffths C, Dziedzic K, Waterfield J, Sim J. Effectiveness of specific neck stabilization exercises or a general neck exercises program for chronic neck disorder: A randomized controlled trail. J Rheumatol.2009; 36 (2): 390-397.
46. Pool JJ, Ostelo RW, Hoving JL, Bouter LM, de Vet HC. Minimal clinically important change of the Neck Disability Index and the Numerical Rating scale for patients with Neck pain. Spine. 2007; 32(26): 3047-3051.
47. Cohen SP, Hooten WM. Advances in the diagnosis and management of neck pain. BMJ. 2017;358:j3221.
48. Genebra CVDS, Maciel NM, Bento TPF, Sime~ao SFAP, Vitta A. Prevalence and factors associated with neck pain: apopulation-based study. Braz J Phys Ther. 2017;21(4):274-280.
49. ShirleyS.Diagnosis and Treatment of Movement Impairment Syndromes. Mosby, St. Louis. 2001
50. Janda V. Muscles and Motor Control in Cervicogenic Disorders: Assessment and Management. Churchill Livingstone, New York, USA. 1994
51. Falla D. Unravelling the complexity of muscle impairment in chronic neck pain. Man The 2004; 9(3): 125-33
52. Morningstar M. Cervical curve restoration and forward head posture reduction for the treatment of mechanical thoracic pain using the pettibon corrective and rehabilitative procedures. J Chiropr Med 2002;1(3):113-118

53. Abdulwahab SS, Sabbahi M. Neck retractions, cervical root decompression, and radicular pain. J Orthop Sports Phys Ther 2000; 30 (1):4-9.
54. Häkkinen A, Salo P, Tarvainen U, Wiren K, Ylinen J. Effect of manual therapy and stretching on neck muscle strength and mobility in chronic neck pain. J Rehabil Med. 2007; 39(7):575-579.

.