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Comparison of two Exercise Programs in Patients with Chronic Neck Pain

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Abstract

Background: Neck pain is one of the most common and most costly musculoskeletal disorders in Western societies, which is characterized by frequent relapses and chronicity. Chronic neck pain is often connected with the muscular imbalance of cervical muscles. Therapeutic exercise improves pain, disability and neck muscle strength in individuals with chronic neck pain. However, there are not enough studies proving the therapeutic value of McKenzie exercises in people with chronic neck pain. *Aim:* To compare the short-term effect of two different exercise programs in improving the symptoms and increasing of strength of the cervical muscles in patients with chronic neck pain. *Material and Methods:* Single-blind study lasting 8 weeks with 24 participants suffering from chronic neck pain. Participants were divided into two groups. The first group followed a combined therapeutic exercise protocol fully adapted to the latest guidelines, which contained a combination of resistance and endurance exercises for the neck muscles. The second group followed a program of McKenzie exercises. Pain, disability, neck muscles pressure pain threshold, active range of motion, maximum isometric strength of neck muscles and endurance of the deep neck flexors were assessed before and after the intervention. For the statistical analysis of the results, the analysis of the variance with repeated measures ANOVA was applied and the significance level was set at $p < 0,05$. *Results:* There was a statistically significant improvement in all the outcome measures in both groups before and after the intervention. However, between groups analysis showed statistically significant differences in maximum isometric strength in favor of the therapeutic exercise group. *Conclusions:* Both the therapeutic exercise and the McKenzie method seem to have beneficial short-term effects in patients with chronic neck pain. However, the maximum isometric strength improved more with endurance and resistance training.

Keywords: chronic neck pain; therapeutic exercise; McKenzie exercises; physical therapy.

1 Introduction

Neck pain is one of the most common musculoskeletal disorders in western societies with high prevalence in the general population of up to 67% (Hudson & Rayan, 2010; Alvarez & Rockwell, 2002) and a significant impact on the quality of life (Fernandes de las penas et al, 2007).

Neck pain shows frequent relapses and chronicity (Kay et al, 2012). Chronic neck pain defined as neck pain with duration of symptoms longer than three months, is associated with changes in the biomechanics of the neck region. The main contributing factor for the persistence of symptoms seems to be the muscular imbalance between the deep and superficial neck flexors. The weakness of deep neck flexors (longus capitis and

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longus colli) leads to tension and muscle spasm in the superficial neck flexors (sternocleidomastoid and anterior scalene) as confirmed by electromyography (Falla et al, 2006). Therapeutic exercise plays a vital role in the restoration of this muscular imbalance. Therapeutic Exercise in the management of chronic mechanical neck pain has been studied extensively over the last 20 years. Recent guidelines, as derived from meta-analysis from A.P.T.A. (American Physical Therapy Association) (Childs et al, 2012; Bertozzi et al, 2013) and Cochrane (Kay et al, 2012; Gross et al, 2015), suggest that the implementation of a 6-10 week combined resistant and endurance training program, 3-5 times a week, reduces pain and improves functional ability.

In the majority of studies either resistance or endurance exercise programs were applied, the effect of exercise on pain, muscle strength and disability of patients with chronic neck pain was examined. Although there has been much debate about which of the two types of training is most appropriate, it appears that greater benefits have been demonstrated in combined exercise programs involving both types of training (Falla et al, 2006; Hudson & Ryan, 2010; Miller et al, 2010; Ylinen 2003).

The intensity of exercise programs for chronic neck pain depends on the type of exercise. Progressive resistance programs are designed using 1RM subdivisions (most commonly 12RM-15RM) (Viljanen et al, 2003; Chiu et al, 2005) with emphasis on avoiding pain or intolerance at the early stages of the program. In such programs, exercise intensity is expressed as a percentage of Maximum Voluntary Contraction (MVC) with submaximal resistance levels, ranging from 20% to 70% of MVC (Hakkinen et al, 2008).

In endurance training programs, the main objective is the improvement of the endurance of deep cervical flexors as well as reeducation of the isolated contraction of longus colli separately from the sternocleidomastoid muscle during upper cervical flexion. These programs are based on the Cranio-Cervical Flexion Test which contains isometric contractions of 10-15sec at progressively increasing resistance by the stabilizer from 20 to 30 mmHg during an upper cervical movement (head nodding movement) (Falla et al, 2006; Ylinen, 2007).

The frequency of exercise programs in line with the recommendations of the American Society of Sports Medicine (http://www.acsm.org) varies in most studies from 3 to 5 times per week, and the duration from 6 to 12 weeks with the first noticeable changes expected after the 4th week (Andersen et al, 2011, Miller et al, 2010, Falla et al, 2006; Chiu et al, 2005; Ylinen et al., 2002; Ylinen et al, 2007).

The McKenzie method began in New Zealand in 1956 and constitutes a frequently used management method for patients with spine mechanical problems until today. It is a well-structured evaluation and treatment system that classifies the mechanical problems of the spine in three basic syndromes (derangement, dysfunction and posture syndrome), each treated in a different and standardized way. Derangement Syndrome involves mechanical obstruction to movement within the joint. Dysfunction Syndrome involves pain caused by the mechanical loading of structurally impaired soft tissues and in Postural Syndrome pain develops from prolonged overloading of tissues. There is also a fourth classification («another»), which includes the subjects that cannot fit any of the three basic syndromes (McKenzie & May, 2003).

During the patient evaluation process, the therapist examines how movement and positions affect patient symptoms. The patient is asked to move in various directions and report back to the clinician on the effect of these various movements. The effect of repeated or static end-range loading on pain patterns can determine, often from the first evaluation, if the application of this technique is indicative for the patient.

The method was originally applied to problems of the lumbar spine (McKenzie, 1981) and was later adopted to the cervical region (McKenzie, 1990). However, few studies highlight the efficacy of the method in patients with chronic neck pain.

In the study by Kjellman and Oberg (2002), 77 patients with neck pain were divided to 3 groups: general exercise group, McKenzie exercise group and control group. Pain intensity and functional ability improved in all three groups before and after the intervention, but no significant differences were found between the three groups. As the researchers explained, the results of their study were affected by the heterogeneity of the participants in relation to baseline severity of symptoms.

In Takasaki and May (2014) meta-analysis, 6 clinical trials were included, with patients with chronic neck pain, which compared the efficacy of the McKenzie method in relation to another intervention or control group. They concluded that the McKenzie method did not effectively reduce pain or improve patient functional ability. However, they pointed out that the therapist's experience plays a really significant role and directly affects the validity of the results.

Seo and colleagues (2012) compared McKenzie exercises with sling exercises in 20 patients with chronic neck pain and found that they both reduce pain and improve cervical ROM and neck strength. However, no significant differences were found between the groups.

In conclusion, there is not enough evidence regarding the relative effectiveness of the McKenzie method in patients with chronic neck pain. Even though the McKenzie technique is commonly utilized by physiotherapists in clinical practice, current research suggests that the heterogeneity of the participants especially the differences in baseline severity of symptoms as well as the implementation of the technique, negatively affect its effectiveness in patient with chronic neck pain. Despite these problems the Mc-Kenzie method emphasize patients' education and self-treatment and it is considered a cost-effective treatment.

The aim of this study was the comparison of the short-term effect of the Therapeutic exercise versus the Mc-Kenzie exercise, on the improvement of the patients' symptoms and on the increase of the cervical muscle strength in patients with chronic neck pain.

2 Method

2.1 Participants

28 in total, male and female patients aged 30-60 years with chronic neck pain participated in this study. Inclusion criteria of the participants were: patients with neck pain, patients with duration of symptoms longer than 3 months and physician referral for physiotherapy. Exclusion criteria were the acute stage of symptoms confirmed by VAS (score >7), participation in any kind of treatment during the last three months, participation in an exercise program concerning neck muscles during the last six months, history of neck trauma and / or surgery in the neck region, inflammatory muscle diseases, joint infections and malignancy. General characteristics of the participants are presented in table 1. In both groups, the majority of the participants were women (71,4% to TE and 78,6% to MCKENZIE). 35,7% of the TE group and 46,5% of the MCKENZIE group performed some type of exercising, whereas the majority of the participants experienced symptoms the duration of which varied from 3 to 6 months. (71,4% TE, 57,1% MCKENZIE).

Table 1. Demographics of the two groups

Group	**T.E. group**		**McKenzie group**	
Age (years)	Mean 47,93	SD 8,62	Mean 45,86	SD 8,29
Gender	Men 28,6% (n=4)	Woman 71,4% (n=10)	Men 21,4% (n=3)	Woman 78,6% (n=11)
Sports (yes/no)	35,7% YES	64,3% NO	46,4% YES	53,6 NO
Duration of symptoms (current cervical pain episode)	3-6 months 6-12 months > 12 months	71,4% 21,4% 7,1%	3-6 months 6-12 months > 12 months	57,1% 35,7% 7,1%

2.2 Design

This was an 8-week single blind controlled trail with 28 male / female participants aged 30-60 years with chronic neck pain. The general study design is illustrated in a flowchart (Figure 1). Participants were informed on the aims and the requirements of the study and those who agreed to participate were asked to sign a written consent form. Participants' recruitment process took place in a private physiotherapy clinic between May and September 2016, with all participants completed the exercise program until November 2016. Allocation of the participants in the two groups was conducted alternately, in order of arrival, during the recruitment period. In the first group (therapeutic exercise group, n = 14), a therapeutic neck exercise training program was applied for 8 weeks while in the 2nd group (McKenzie group, n = 14), a McKenzie exercise program was applied for the same period. The two exercise programs were applied by two different physiotherapists who had significant experience in neck pain management, while the assessment of outcomes was conducted by an independent researcher who was blind to the treatment groups. Both participants and therapists could not be considered blind regarding the study design.

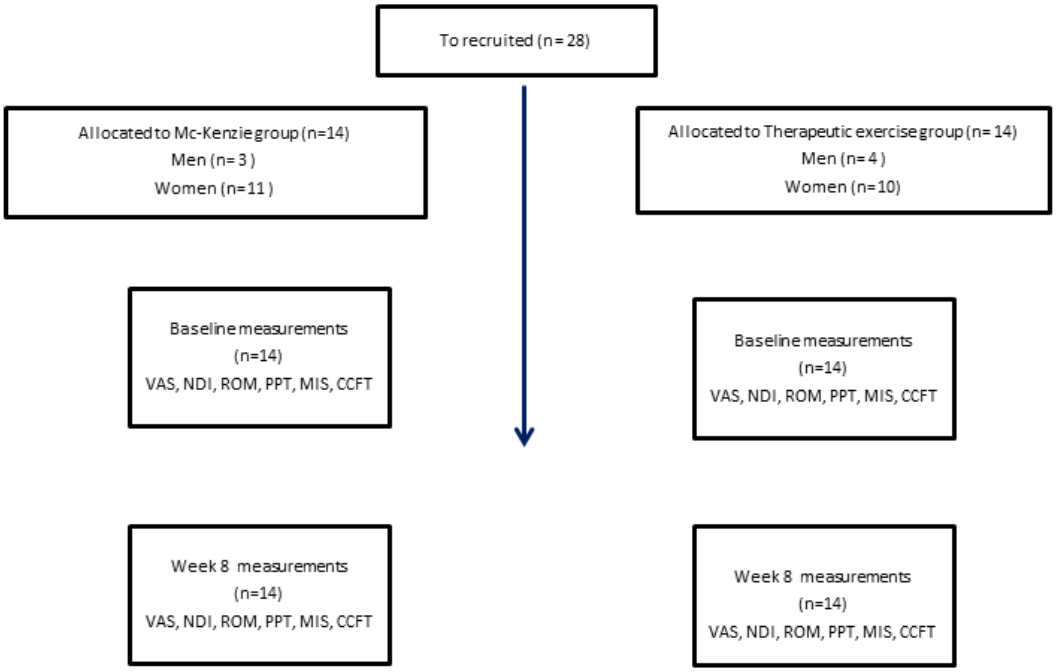

Figure 1. Flowchart of general study design and number of participants during each phase of the study.; VAS visual analog scale; NDI, neck disability index; ROM, range of motion; PPT, pressure pain threshold; MIS, maximum isometric strength; CCFT, craniocervical flexion test.

2.3 Outcome measurement

The following outcome measures were used before the treatment and at the end of the intervention (after 8 weeks).

2.3.1 Pain intensity with the Visual Analogue Pain Scale (VAS).

VAS is a card with an uncalibrated scale ranging from zero to hundred (with zero representing no pain and hundred representing the worst pain in life). The patient subjectively estimated their pain level by marking a vertical line on the uncalibrated scale between 0-100mm. Then, the exact value of pain intensity could be obtained with a single ruler. Thus, the highest value corresponds to more intense pain (Hawker et al, 2011). VAS is widely used as it is easy to implement, and it is characterized by good psychometric properties.

2.3.2 Pressure Pain threshold (PPT) with pressure algometry.

PPT is defined as the minimal amount of pressure that produces pain on a muscle belly. Pressure algometry was conducted by a Wagner analog algometer (FDN 200 Wagner Instruments). For the procedure of PPT measurement, the protocol recommended by Fischer was applied (Fischer et al, 1994). Pressure pain threshold was assessed bilaterally over the upper border of the trapezius muscle halfway between the midline and the lateral border of the acromion, and to the levator scapulae muscle 2 cm above the lower insertion, located in the upper medial border of the scapulae. PPT measurement reliability has been characterized from medium to high in both repeated measurements of the same examiner, as well as between measurements of different examiners (Reeves et al, 1986).

2.3.3 Disability using the Neck Disability Index (NDI) questionnaire

NDI is a self-reported ten-item scale. Each item assesses restrictions related to neck pain. Most of the items are related to restrictions in activities of daily life, and each item is expressed by 6 different assertions in the range 0-5, with 0 indicating no disability and 5 indicating the highest disability (Pietrobon et al, 2002). The total score ranges from 0 to 50. NDI has sufficient support in literature, being the most commonly used tool to assess neck pain related disability. The Greek version of the questionnaire was used for this study (Trouli et al, 2008).

2.3.4 Maximum isometric strength (MIS) of neck muscles with Manual Muscular Testing.

Cervical flexion and extension MIS were assessed using a Manual Muscular Testing device (Gauge Gage HF-500N) with the participants in supine and prone position. The measurements from these positions depict high reliability (Dvir & Prushansky, 2008). The procedure was explained in detail to the patient. Prior to testing, the individual performed some active, pain free ROM movements to prevent pain or injury during his effort. The dynamometer was then placed on patient's head and the examiner gradually increased the resistance (at a rate of about 3kg / sec) while the participant tried to keep his head from moving. When the participant 's head was moved more than 3-4 degrees, or when he gave up trying, the measuring process was stopped, and the highest value of the dynamometer was recorded in kg. To avoid muscle fatigue or pain, only one measurement was performed in each direction.

For flexion MIS measurement, the individual was placed in a supine position with the upper cervical spine in flexion (nodding movement). Then keeping the upper cervical flexion participant was instructed to lift his head of the bed about 30^0. As soon as the patient's head was stabilized in that position the examiner exerted pressure against patient's flexion. For extension MIS measurement the participants were placed in the prone position. The shoulders were supported by the examination bed while the head was in the air. The examiner had to keep the head against gravity in the neutral position. Then the examiner, placing the dynamometer on the base of the occipital bone, pushed the head of the participant downwards against his effort.

2.3.5 Cervical Range of Motion (ROM) using a bubble inclinometer.

Cervical active range of motion was measured with two bubble inclinometers. One was placed on the top of the head while the second one on the spinous process of C7. Active cervical flexion, extension, and side bending ROM were assessed with Participants sitting in upright position. Bubble inclinometer reliability has been proven in the past (Pringle, 2003).

2.3.6 Deep flexors muscle endurance with craniocervical flexion test (CCFT).

The CCFT assesses indirectly the deep neck flexors muscles fatigue. It is performed using a pressure sensor placed under the patient's neck (Chattanooga Stabilizer Pressure Biofeedback) and includes flexion of the upper cervical spine in 5 progressive conditions. Its validity has been verified using electromyography (Jull et al, 2008).
Test procedure was explained in detail to the participant and was given time to familiarize himself with both the stabilizer device and the movement of the upper cervical flexion. The participant was placed in a supine position with his neck supported by the table. In order

to achieve the neutral position a small roll was placed under the occipital bone. The examiner checked visually the participant‘s head neutral position.

Then inflatable air-filled pressure biofeedback sensor was placed between the neck of the participant and the bed and was inflated by the subject up to 20mmHg. Each participant had to perform upper cervical flexion until the pressure increased sequentially to 22, 24, 26, 28, and 30 mmHg and hold this pressure on each level for 10 sec. When the individual successfully completed the 10sec effort on one level, he had a 30sec break before attempting the next level. The test was completed when the examiner could not keep the 10sec contraction at the same level or when he completed the 10sec contraction at 30mmHg.

2.4 Therapeutic exercise (T.E.) group protocol

The therapeutic exercise (T.E.) program lasted for 8 weeks with a frequency of 4 times a week, and the duration of each session was 45'. The Programme included both endurance and resistance training. Endurance training included exercises for the deep neck flexors (10sec of head nodding from different upper cervical flexion angles with a stabilizer through the implementation of the Craniocervical flexion test from 20mmHg to 30mmHg). Resistant training included isometric (20-70% of MVC) and isotonic (with resistance of 12-15RM) exercise with resistance bands to all directions at the limits of patient’s pain. Endurance exercises were conducted first during each training session.

2.5 McKenzie group protocol

Because of the individualized character of this method, it was considered a mistake for all the patients of McKenzie group to follow an identical exercise protocol. Instead, the correct evaluation and application of the method during treatment was thought to be of major importance. Each patient was evaluated for severe contraindications (red flags) and based on the response of their symptoms during the gradually loading (specific repetitive movements), they were ranked according to McKenzie's classification system in one of the three mechanical syndromes (derangement, dysfunction and postural syndrome). One or more of the following exercises were performed for the treatment of the patients from sitting and prone position: cervical neck retraction, cervical neck retraction and neck extension, neck flexion and right and left cervical side bending. The duration of each movement ranged from 7 to 10 seconds while the number of repetitions ranged from 10 to 20. The frequency of the sessions ranged from 3 to 1 per week for a total period of 8 weeks. Emphasis was given on the appropriateness of the performance of these exercises that reduced the symptoms and instructions were given to patients to perform them several times per day at home. The type of exercises, the frequency of the treatments and the number of repetitions were different for each patient as deemed necessary by the initial examination and the re-assessments.

2.6 Statistical analysis

Data were analyzed using SPSS for Windows, Version 17.0 (SPSS Inc., Chicago, IL, USA). The repeated measures ANOVA was applied to each dependent variable. The between groups factor was assessed at two levels (Therapeutic exercise Group and McKenzie Group), and the repeated measures factor also at two levels (baseline measurement and after 8 weeks). The level of significance was set at $p < 0,05$. Furthermore, for the description of the demographic characteristic of the participants, descriptive and frequency analysis were applied (table 1).

3 Results

3.1 Pain intensity (VAS)

Repeated measures Analysis of variance revealed a significant group × time interaction for changes over VAS score (F=27,937, p<0,001). Also, a main effect on measurements on the "time of measurement" factor was observed (F=128,411, p<0,001). In contrast, there was no significant effect of group factor measurement (F=490,810, p>0,05).
VAS score diminished in both groups. However, from Table 2 and Figure 2, it seems that the therapeutic exercise group showed greater improvement than the McKenzie group, but this difference was not statistically significant.

Table 2. Mean values and standard deviations for VAS score for the two groups before and after treatment.

Time of measurement	T.E. group		McKenzie group	
	Mean	SD	Mean	SD
VAS baseline measurement	5,47	0,79	5,66	0,95
VAS after 8 weeks	1,98	1,1	3,09	1,08

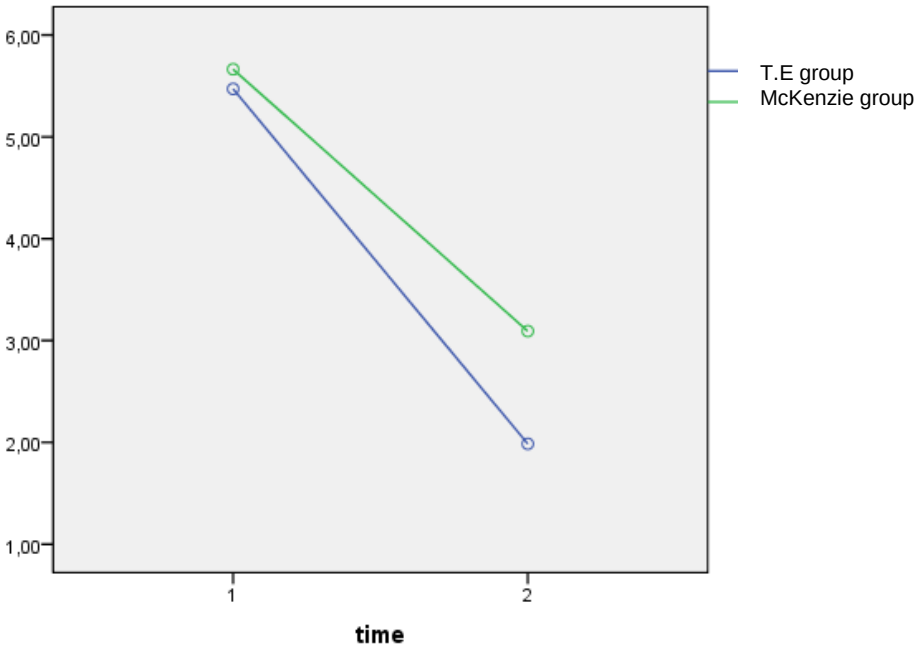

Figure 2. Interaction of "time of measurement" and "group" factors for VAS score

3.2 Neck Disability (NDI)

Repeated measures Analysis of variance revealed a significant group × time interaction for changes over NDI score (F=9,390, p<.05). Also, a main effect on measurements on the "time of measurement" factor was observed (F=383,053 and p<0,001). In contrast, there was no significant main effect of group factor measurement (F=2,268, p>0,05).

Similar to VAS score, the NDI score diminished in both groups. However, from Table 3 and Figure 3, it seems there was a trend for greater improvement in the therapeutic exercise group compared to the McKenzie group, but this difference was not statistically significant.

Table 3. Mean values and standard deviations for NDI score for the two groups before and after treatment.

Time of measurement	T.E group		McKenzie group	
	Mean	SD	Mean	SD
NDI baseline measurement	32,5	2,59	32,07	2,09
NDI after 8 weeks	16,14	4,47	20,14	4,78

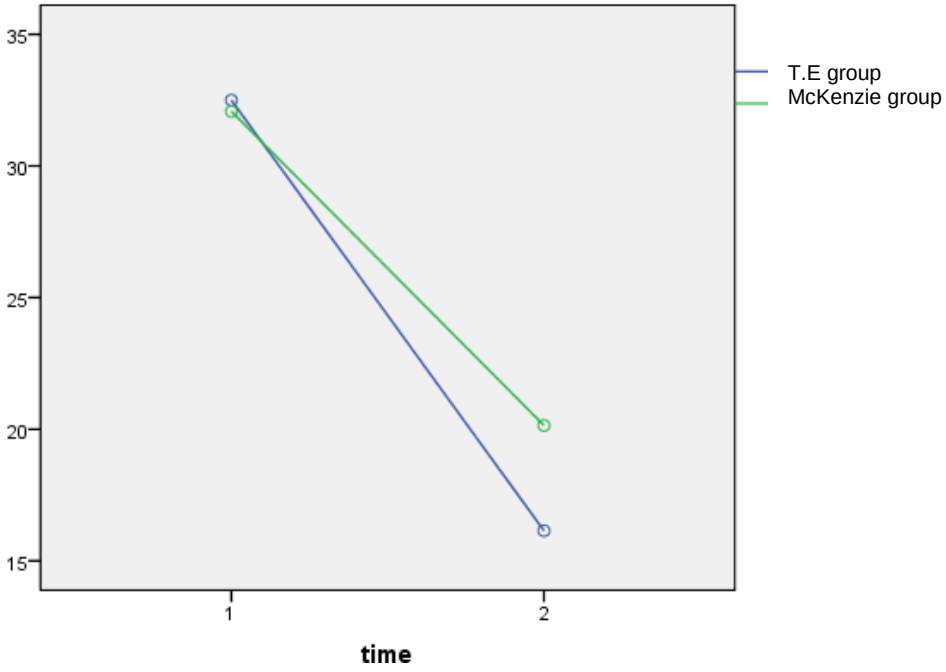

Figure 3. Interaction of "time of measurement" and "group" factors for NDI score

3.3 Maximum isometric strength (MIS)

Repeated measures Analysis of variance revealed a significant group × time interaction for changes over isometric strength of cervical flexors (F=26,765, p<.001) and cervical extensors (F=19,166, p<.001). Also, a significant main effect of the “time of measurement” factor was observed over cervical flexion (F=255,899, p<0,001) and cervical extension (F=82,892, p<0,001). a main effect on the group factor was also observed over cervical flexion (F=7,52 p<.05) and cervical extension (F=5,268, p<.05). The maximum isometric strength of cervical flexors and extensors improved in both groups. However, from Tables 4 and 5 and Figures 4 and 5, it seems that the therapeutic exercise group showed greater improvement than the McKenzie group, and this difference was statistically significant.

Table 4. Mean values and standard deviations of maximum isometric strength (MIS) of cervical flexors for the two groups before and after treatment (kg).

Time of measurement	T.E. group		McKenzie group	
	Mean	SD	Mean	SD
Flexion MIS baseline measurement	6,2	1,43	6,0	1,25
Flexion MIS after 8 weeks	10,64	1,64	8,27	1,0

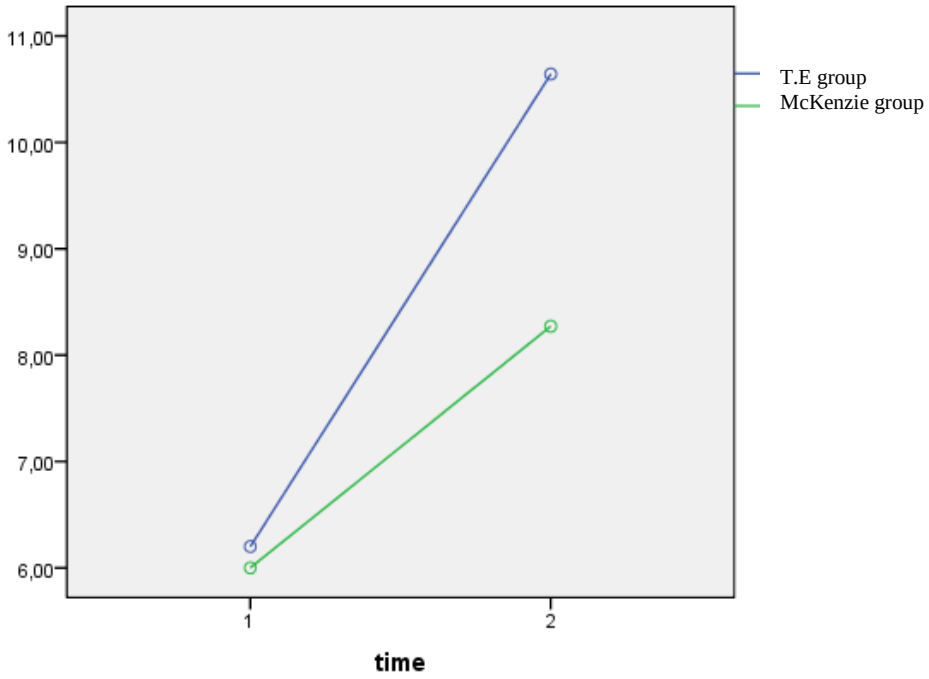

Figure 4. Interaction of "time of measurement" and "group" factors for maximum isometric strength of cervical flexors.

Table 5. Mean values and standard deviations of maximum isometric strength (MIS) of cervical extensors for the two groups before and after treatment (kg).

Time of measurement	T.E. group		McKenzie group	
	Mean	SD	Mean	SD
Extension MIS baseline measurement	13,58	2,00	13,30	1,93
Extension MIS after 8 weeks	17,31	2,15	14,61	1,23

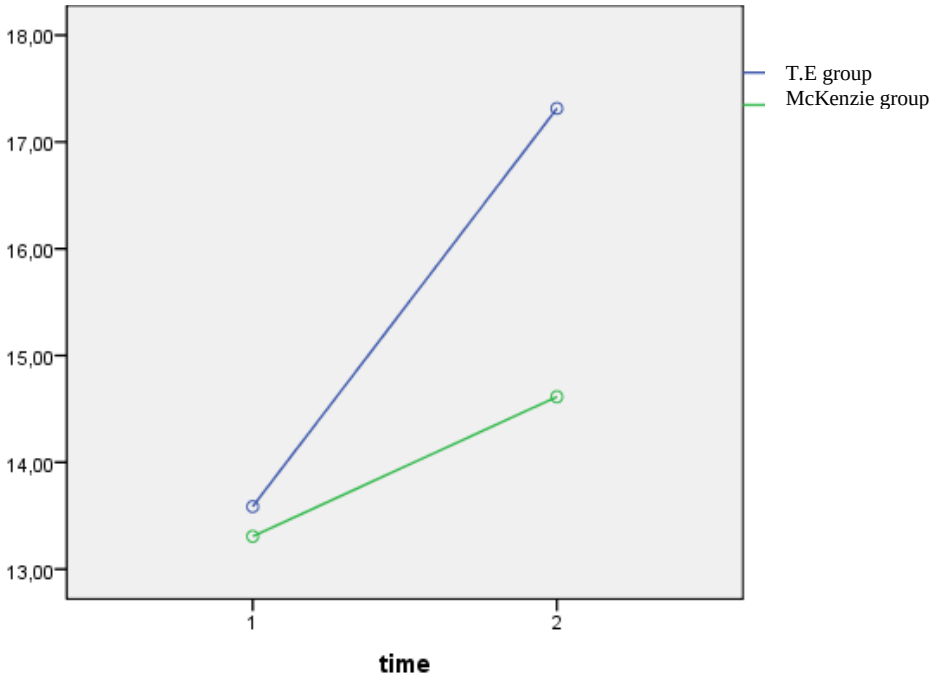

Figure 5. Interaction of "time of measurement" and "group" factors for maximum isometric strength of cervical extensors.

3.4 Pressure Pain threshold (PPT)

Right upper trapezius. There was a significant group × time interaction for changes over the right trapezius PPT (F=4,647, p<.05), Also, a main effect of the “time of measurement” factor was observed (F=104,857, p<0,001) while there was no significant main effect of the group factor measurement (F=2,288, p>0,05).

Left upper trapezius. There was a significant group × time interaction for changes over left trapezius PPT (F=0,488, p>.05). Also, a main effect of the “time of measurement” factor was observed (F=82,409, p<.001), while there was no significant main effect on the group factor measurement (F=2,032, p>0,05).

Right levator scapula. There was not any significant group × time interaction for changes over the right elevator PPT (F=0,079, p>.05). There was a main effect of the “time of measurement” factor (F=209,471, p<.001) while there was no significant main effect of the group factor measurement (F=.275, p>.05).

Left levator scapula. There was not any significant group × time interaction for changes over the left elevator PPT (F=2,299, p>.05). There was a main effect of the “time of measurement” factor (F=209,471, p<.001), while there was no significant main effect of the group factor measurement (F=.379, p>.05).

It appears that the upper trapezius and elevator scapulae PPT improved in both groups. Slightly more so in the Therapeutic exercise group but this difference was not statistically significant (Table 6, Figure 6).

Table 6. Mean values and standard deviations for neck muscles PPT for the two groups before and after treatment (kg/cm^2).

Time of measurement	T.E. group		McKenzie group	
	Mean	SD	Mean	SD
Right trapezius PPT baseline measurement	2,97	0,38	2,93	0,35
Right trapezius PPT after 8 weeks	4,78	1,01	4,11	0,92
Left trapezius PPT baseline measurement	3,43	0,23	3,25	0,34
Left trapezius PPT after 8 weeks	4,63	0,74	4,27	0,84
Right elevator PPT baseline measurement	4,70	0,66	4,45	0,71
Right elevator PPT after 8 weeks	6,75	1,43	6,60	1,39
Left elevator PPT baseline measurement	4,54	1,01	4,51	0,86
Left elevator PPT after 8 weeks	7,02	1,34	6,52	1,49

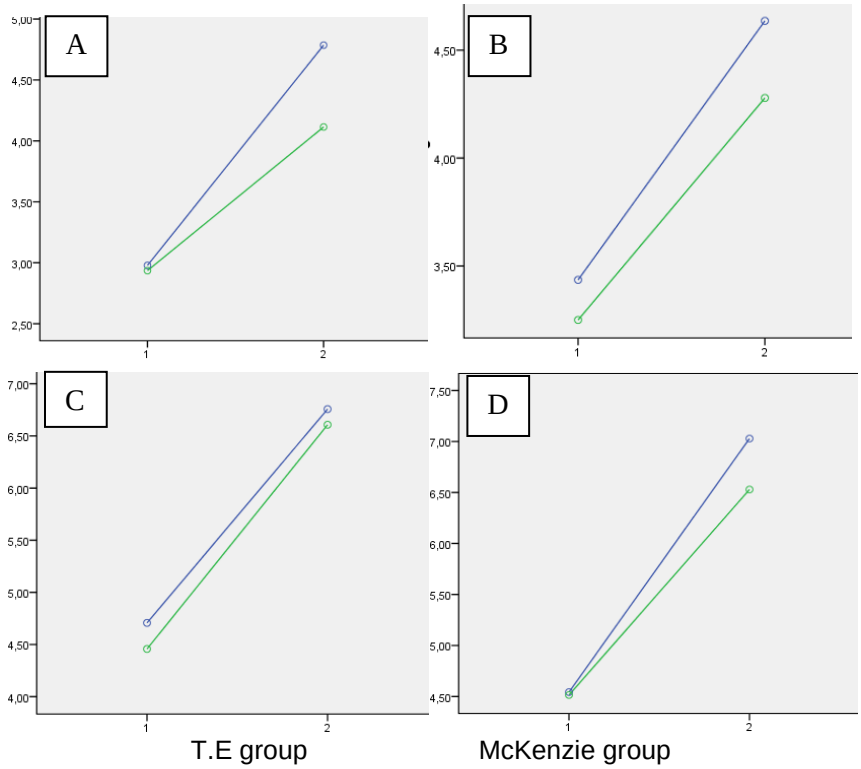

Figure 6. Interaction of the "time of measurement" and “group” factors for the neck muscles PPT.
A: Right trapezius PPT
B: Left trapezius PPT
C: Right elevator PPT
D: Left elevator PPT

3.5 Craniocervical flexion test (CCFT) results

Repeated measures Analysis of variance revealed a significant group × time interaction for changes over CCFT score (F=4,592, p<.05). Also, a main effect of the "time of measurement" factor was observed (F=74,740 and p<.001). By contrast, there was no significant main effect of the group factor measurement (F=.571, p>.05).

It appears that the CCFT score improved in both groups. However, from Table 7 and Figure 7, it seems that the therapeutic exercise group showed greater improvement than the McKenzie group, but this difference was not statistically significant.

Table 7. Mean values and standard deviations of craniocervical flexion test (CCFT) for the two groups before and after treatment.

Time of measurement	T.E. group		McKenzie group	
	Mean	SD	Mean	SD
CCFT score baseline measurement	23,57	1,94	24,14	1,46
CCFT score after 8 weeks	28,78	2,99	27,28	1,48

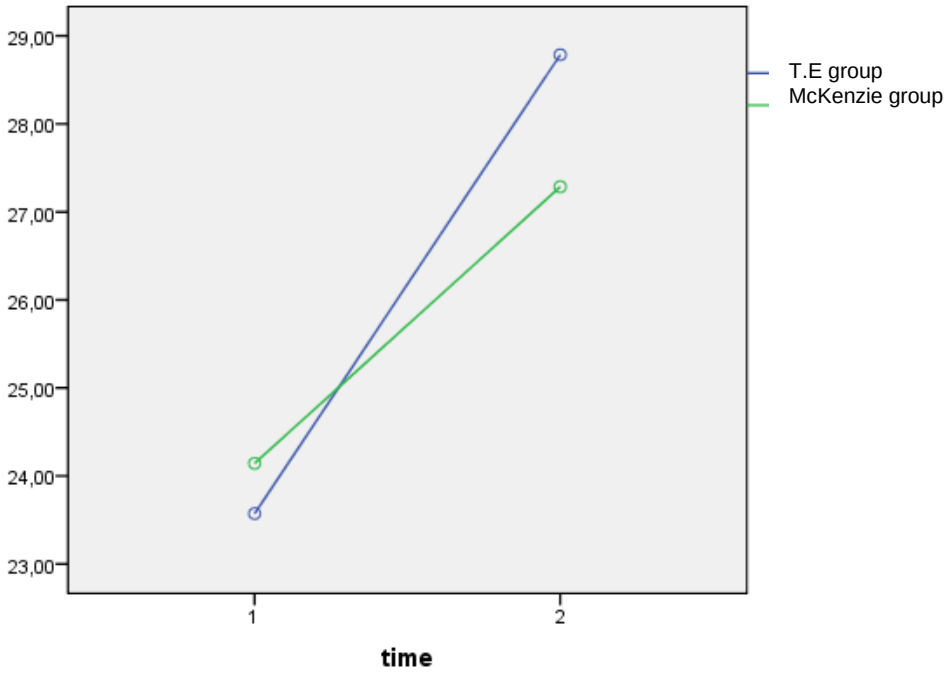

Figure 7. Interaction of "time of measurement" and "group" factors for CCFT score.

3.6 Cervical range of motion (ROM)

Flexion ROM. There was not any significant group × time interaction for changes over ROM Flexion (F=1,688, p>.05). Also, a main effect of the "time of measurement" factor was observed (F=68,284, p<0,001). In contrast, there was no significant main effect on the group factor measurement (F=.537 p>0,05).

Extension ROM. Repeated measures Analysis of variance revealed a significant group × time interaction for changes over the cervical extension ROM (F=7,713, p<.05). Also, a main effect of the "time of measurement" factor was observed (F=84,563 και p<0,001). On the contrary, there was no significant main effect of the group factor measurement (F=.008 p>.05).

Right side bending ROM. There was a significant group × time interaction for changes over the right side bending ROM (F=5,887, p<.05). Also, a main effect of the "time of measurement" factor was observed (F=114,286, p<0,001), while there was no significant main effect on the group factor measurement (F=.000, p>.05).

Left side bending ROM. There was a significant group × time interaction for changes over the left side bending ROM (F=6,278, p<.05). Also, a main effect of the "time of measurement" factor was observed (F=139,109, p<.001), while there was no significant main effect on the group factor measurement (F=.095, p>.05).

It appears that the cervical ROM improved in both groups but this difference was similar for both groups (Table 8, Figure 8).

Table 8. Mean values and standard deviations for cervical active range of motion (ROM) for the two groups before and after treatment (degrees^0).

Time of measurement	T.E. group		McKenzie group	
	Mean	SD	Mean	SD
Flexion ROM baseline measurement	46,71	4,00	48,92	5,03
Flexion ROM after 8 weeks	53,28	4,87	53,71	6,25
Extension ROM baseline measurement	54,71	4,98	56,50	5,01
Extension ROM after 8 weeks	61,64	6,04	60,21	5,72
Right side bending ROM baseline measurement	37,14	3,57	38,00	3,61
Right side bending ROM after 8 weeks	40,85	3,39	40,00	3,41
Left side bending ROM baseline measurement	32,64	4,46	33,64	5,51
Left side bending ROM after 8 weeks	41,00	3,32	39,07	3,45

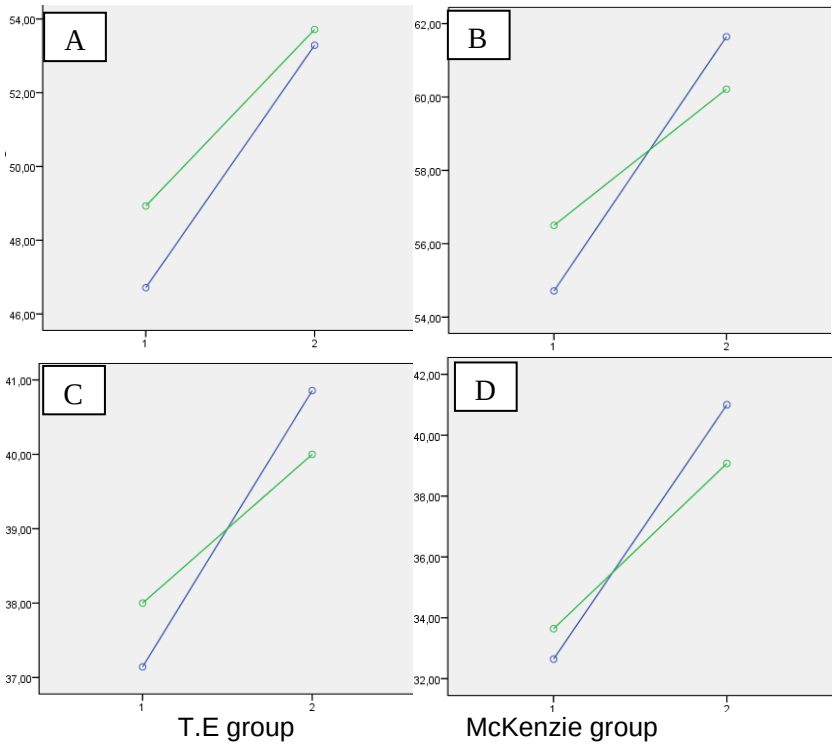

Figure 8. Interaction of "time of measurement" and "group" factors for cervical ROM
A. Flexion ROM
B: Extension ROM
C: Right side bending ROM
D: Left side bending ROM

4 Discussion

This study investigated the short-term effect of two exercise programs on symptoms, neck muscle strength and endurance in patients with chronic neck pain. Therapeutic exercise is a widespread and widely accepted way of managing chronic neck pain. Exercise adaptations bring not only short-term but also long-term benefits by improving pain and disability to these patients (Kay et al, 2012; Gross et al, 2015). In the present study a combined protocol of strength and endurance training based on Jull and colleagues (2009) has been utilized. The effectiveness of this exercise program has been demonstrated in previously (Hudson & Ryan, 2010; Gross et al, 2015). On the other hand, the McKenzie method, while being a commonly used method in clinical practice, there was limited evidence supporting its relative effectiveness in chronic neck pain patients. This may be due to the fact that, McKenzie intervention was applied universally in a heterogeneous group of patients despite the strict suggestions of its founder regarding individualized assessment and treatment of each patient. Consequently, its effectiveness depends not only on the correct application but also on the therapist's experience and ability (Takasaki & May 2014).

In the present study, great attention was given to the homogeneity of the participants, regarding the severity of symptoms in the initial assessment, as this could affect the results, as reported by Kjellman and Oberg (2002). For this purpose, the VAS score over

7 was considered as an exclusion criterion for this study. In that way, we attempted to ensure that the patients although suffering from chronic neck pain, were not hyper-irritable. In addition, the general characteristics of the participants, were similar to those of other studies using larger samples (Falla et al, 2006; Hudson & Ryan, 2010; Miller et al, 2010; Ylinen, 2003).

Pain decreased equally to both groups after the intervention. The improvement in the VAS value in the therapeutic exercise group (3.49 or 63.8% compared to the initial measurement) was equal to other similar studies (Falla et al, 2006; Hudson & Ryan, 2010 Miller et al., 2010; Ylinen 2003). On the other hand, the decrease in the VAS value recorded in the Mc-Kenzie exercise group (2.57 or 45.4% compared to the initial measurement) was much higher than other similar studies (Kjellman & Oberg, 2002; Takakasi & May, 2014; Seo et al., 2012). The fact that the VAS value dropped by 45.4% in the McKenzie team means that applying Mc-Kenzie exercises effectively helped the participants in this group to relieve their pain. Another explanation might be the homogeneity of the sample in relation to baseline severity.

The NDI score was also significantly decreased in both groups after the intervention without any statistically significant differences between the groups. In the therapeutic exercise group, the NDI score diminished by 16 points (50,3% less compared to the baseline measurement) and by 12 points in the Mc-Kenzie exercise group (37,2% less compared to the baseline measurement). Previous studies also indicated a similar decrease in NDI scores after 10-12 weeks of therapeutic exercise interventions (Falla et al, 2006; Hudson & Ryan, 2010). In contrast to other studies the reduction in the Mc-Kenzie exercise group, was greater than previously reported (Kjellman & Oberg, 2002; Takakasi & May, 2014; Seo et al, 2012). This NDI score improvement in the Mc-Kenzie group probably reflects the reduction of pain levels before and after the intervention and demonstrates the effectiveness of the Mc-Kenzie protocol to effectively improve functional capacity.

PPT values of the testing muscles were similar to previous studies performed in patients with chronic neck pain (Ylinen 2007; Ylinen et al, 2003). PPT values reduced in both groups after the intervention in all testing muscles without any significant differences between the groups. These results lead us to the conclusion that both therapeutic exercise and Mc-Kenzie exercise had a positive effect on reducing pain sensitization due to neck pain.

Both ROM and the Craniocervical flexion test score equally improved in both groups after the intervention. Perhaps the deficits in ROM and muscle endurance were both driven by pain and the reduction in pain improved both outcomes. Similar effect was demonstrated for disability as well. This unidimensional etiology of disability is quite remarkable. A possible explanation is that both interventions were active and required participation and responsibility on behalf of the patient. Perhaps this reduced fear of movement and self-efficacy/internal locus of control of the patients. This mechanism can explain the observed improvements in disability, ROM, and performance in CCFT.

However, statistically significant differences between the groups were observed only at the maximum isometric strength values. The Flexion MIS increased after the intervention by 4,44kg in the therapeutic exercise group and by 2,27kg in the Mc-Kenzie group. Extension MIS was increased by 3,73kg in the therapeutic exercise group and by 1,31kg in the Mc-Kenzie group. This MIS values improvement is equal to previous studies (Falla et al, 2006; Hudson & Ryan, 2010; Miller et al., 2010; Ylinen 2003). This difference in strength adaptation seems reasonable, considering the specificity rule of exercise

training. This means that because the therapeutic exercise programme included resistance exercises up to 70% of the MVC neck muscles, is expected to have higher adaptations that the McKenzie protocol which utilizes active end-range exercises without additional resistance.

In conclusion, the fact that the VAS, NDI, PPT, ROM and CCFT scores improved equally in both groups, suggests that the McKenzie method is equally effective in improving the clinical presentation of chronic neck pain patients.

5 Conclusion

Both therapeutic exercise and McKenzie exercise appear to have a positive effect on pain, disability, neck muscles PPT, active ROM and neck muscle strength in patients with chronic neck pain and moderate irritability. However, therapeutic exercise seems to be more effective in improving maximum isometric strength of neck muscles than McKenzie exercises. Further research is necessary in order to investigate the long-term effects of McKenzie exercises in patient with chronic neck pain.

6 Limitations of the study

The small number of participants, along with the lack of randomization increases the chances of bias in this study. In addition, because of the sequential recruitment of the sample from a private physiotherapy clinic the results of the present study might not be representative of the whole population of neck pain patients. Because of the type of the intervention, neither the patients nor the therapists could be blind to study intervention however an effort was made to reduce bias by utilizing an independent assessor blind to group allocation to examine all outcome measures.

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