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Effect of Cervical Stability Exercises on Neck Pain and Disability in Patients with Cervical Spondylosis: A Randomized Controlled Study

{Polish abstract}

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Abstract

Purpose. To investigate the effect of cervical stability exercises (CSE) on neck pain and neck functional disability in patients with cervical spondylosis.

Methods. Randomized controlled trial. Overall, 40 patients of both genders with age ranged from 40-65 years with mild to moderate cervical spondylosis were recruited randomly and divided into two equal groups; Group (A) (control group), received traditional treatment of cervical spondylosis for 4 weeks, Group (B) (experimental group), received the same traditional treatment plus CSE for 4 weeks. Pre- and post-treatment assessment using Visual analogue scale (VAS) and neck disability index (NDI) were done for all patients.

Results. The comparison between both groups post-treatment revealed statistically significant reductions in VAS, as well as NDI total score and NDI subscores ($p < 0.05$) in favour of experimental group (B).

Conclusion. Cervical stability exercises have a significant effect on reducing pain and improving function in patients with cervical spondylosis.

Key words:

Cervical spondylosis, Cervical stability exercises, Neck pain, Neck disability index

Streszczenie

{Polish abstract}

Słowa kluczowe

{Polish keywords}

Introduction

Cervical spondylosis is a progressive degenerative disease that affects cervical intervertebral discs, facet joints and soft tissues causing pain, headache, stiffness and neurological manifestations, leading to cervical lordosis and instability [1, 2]. Multitude of causes and factors might contribute to the development of cervical spondylosis, including anxiety, neck strain, depression, behaviors like poor posture, housework activity, sleep, and occupational or sporting activities [1, 3]. Many risk factors have been attributed to the development of cervical spondylosis such as age, sex, race, occupation, height and weight [4]. Patients with age range of 45 to 60 years old constitute the highest prevalence risk group, with females more affected than males [2-4]. Short height subjects are more susceptible to develop radiculopathy and cervical spondylosis. Household workers, outdoor workers, manual laborers and head load carriers are the highest occupational risk factor of cervical spondylosis [4].

Cervical spondylosis presents with multiple range of signs and symptoms such as, cervical pain that increases by movement with referring the pain to occiput, in between the blades of shoulder, and upper extremities, or temporal pain, tingling sensations, and vague numbness in upper extremities, as well as poorly localized tenderness in the neck. Cervical stiffness, or upper limb weakness with limited range of motion (ROM), that impact functional abilities of the patient are usually seen in cervical spondylosis. Dizziness, vertigo, headaches and/or poor balance might as well be observed [1, 2]. Cervical spondylosis is often diagnosed on the basis of clinical symptoms and signs alone [1]. Although focusing on clinical symptoms and signs, the diagnosis might be confirmed by diagnostic imaging such as X-ray, computed tomography, magnetic resonance imaging and electromyography (EMG) [5]. Plain cervical X-ray may show loss of normal cervical curvature, suggesting overactivation of superficial cervical flexors and muscle spasm [1].

Muscle imbalances occur when the superficial muscles dominate and become short while the deep muscles become weak and inhibited [6]. The weakness of deep cervical flexor (DCF) muscles as a result of improper life style, muscle fatigue, and/or poor ergonomics would eventually lead to overactivation of the superficial flexor muscles and hence muscle imbalance, these would result in forward head posture, rounded shoulder, and alteration in normal neck biomechanics [7]. Therefore, exercise is the most appropriate tool in the process of rehabilitation for cervical pain patients [8]. As spinal stability system depends on integration of active subsystem as the muscles, passive subsystem (ligaments and osseous elements) and neural elements (neuromuscular control) to provide a constant feedback, a complete stabilization exercise program should include both sensory and motor components for achieving the optimal spinal stabilization. Core stability, strengthening and endurance exercises are the most important exercises that ensure spine stability and injury prevention [6].

Cervical stability exercises (CSE) are useful to strengthen cervical muscles and supporting ligaments, aiming mainly to slow the progression of the disease, improving spinal stability and decreasing pain and disability, thus improving quality of life [9-11]. Craniocervical flexor-muscle exercise increases the cervical stability and enhances cervical neuromuscular control of the DCF muscles especially the longus capitis and longus colli muscles. Owing to their ability to maintain normal neck biomechanics, stability exercises gained wide acceptance in the rehabilitation approaches of many musculoskeletal diseases [12, 13]. The coordination between superficial and DCF muscles in patients suffering from neck pain, revealed that during craniocervical flexion, the amplitude of EMG activity of DCF was reduced while that of superficial flexor muscles was increased, indicating that the weakness of DCF, occurring in cervical spondylosis, was compensated by increased activity of superficial neck flexors [14]. Moreover, it is reported that reactivating DCF muscles, through CSE, aids the motor control reorganization and superficial muscle activity levels normalization in cervical pain [7, 9, 11]. Therefore, this study aimed to investigate the effect of CSE on neck pain and neck functional disability in patients with cervical spondylosis.

Subjects and methods

Design

A randomized control trail was conducted to investigate the impact of CSE on pain and functional ability of the neck in patients with cervical spondylosis. Data were collected pre and post treatment from October 2019 to March 2020. Research Ethics Committee before study commencement [No. P.T.REC/012/003127].

Participants

Forty patients of both genders with age ranged from 40 to 65 years classified as mild to moderate cervical spondylosis were recruited from the outpatient clinic of Badr University, Cairo, Egypt. Exclusion criteria included previous neck traumas or injuries, infection, tumor, any peripheral circulatory abnormality e.g. peripheral arterial diseases or deep venous thrombosis, presence of internal fixation, cardiovascular problems that might interfere with performing the exercise program, malignancy, temporomandibular disorders, and patients performing any neck strengthening or stretching exercises other than the program included in the study [14].

Randomization

The recruited patients were randomly assigned, after signing consent form, into two equal groups. A single blind randomization was carried out by assigning the odd numbers to group (A) (control group) and the even numbers were assigned to group (B) (experimental group). Following randomization, there was no dropping out of subjects from the study, Figure 1.

Interventions

Group (A) (control group) included 20 participants who received traditional treatment of cervical spondylosis for 4 weeks, whereas Group (B) (experimental group) included 20 participants who received the same traditional treatment plus CSE for 4 weeks.

The traditional program

All participants in both groups (A & B) received twelve sessions of traditional treatment for cervical spondylosis which

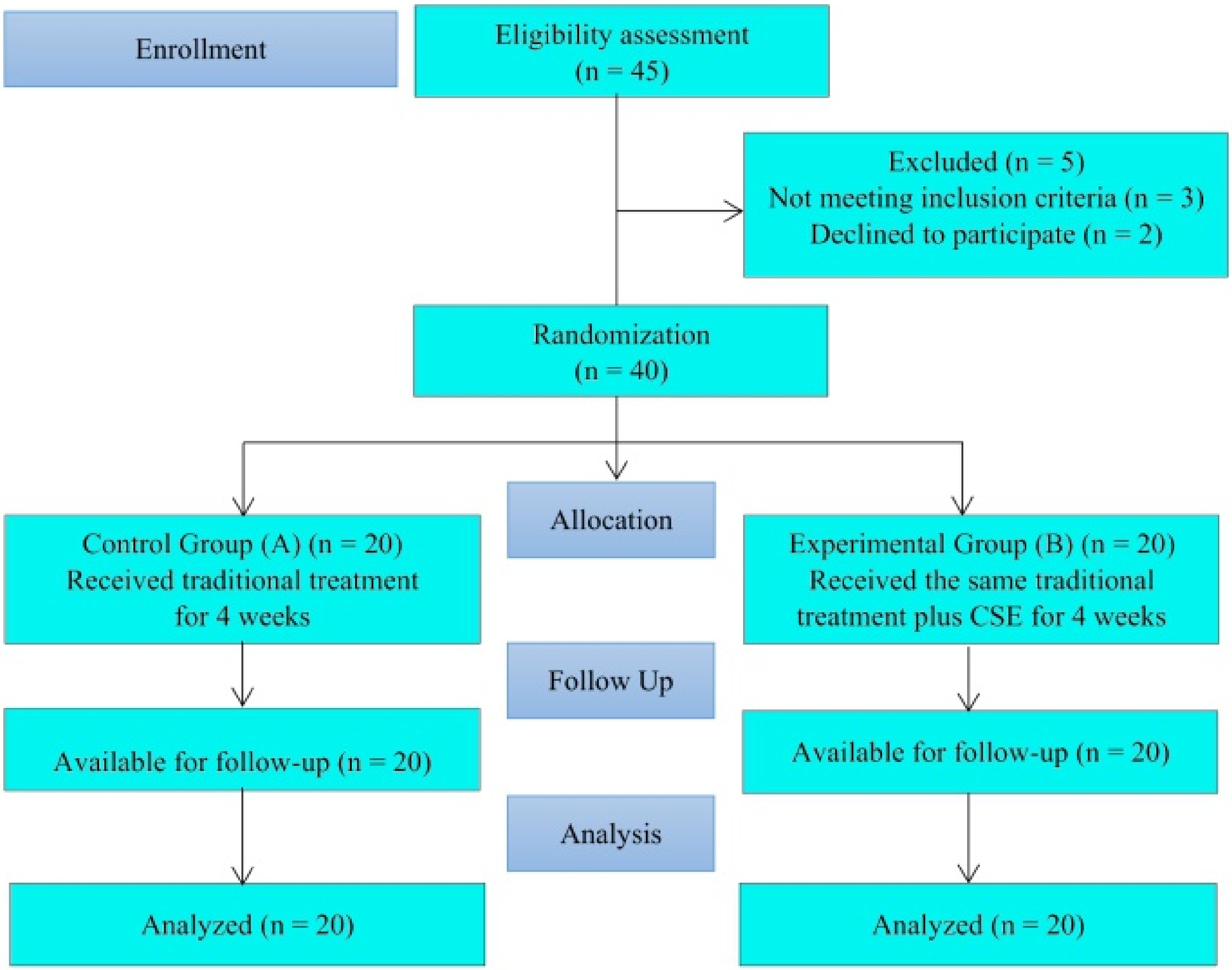

Figure 1. Flow chart of the study

was comprised of hot packs, ultrasound and suboccipital muscles stretch, three sessions per week for four weeks. Hot pack was applied on the paraspinal muscles of the neck for 15 minutes [15]. The ultrasound was applied on paraspinal muscles with parameters set at 1 MHz, 1.5 watt/cm for 10 minutes [16]. Suboccipital muscle stretch was applied from sitting position as the therapist identified and stabilized the second cervical vertebral spinous process by the thumb then the participant was asked to nod his/her head slowly, and hold this position for 30 seconds and repeat it three times [14].

Cervical stability exercises (CSE)

Each participant in group (B) received CSE for twelve sessions, three sessions per week for four weeks. CSE included strengthening exercises of DCF muscles which included chin tucks, isometric holds, ball squeeze, as well as deep cervical extensor (DCE) muscles which included craniocervical flexion from neutral, upper cervical rotation and extension of cervical spine [14].
Concerning DCF muscles strengthening exercises, chin tucks were performed from sitting position for three sets of twelve repetitions with holding six seconds each [14]. Isometric holds with chin tucks were performed from supine lying position and holding the chin retraction against mattress, with six seconds hold for six repetitions [17]. Ball squeeze was performed from sitting position, with the participant holding a small ball between the chin and the chest. The participant was requested to perform isometric contraction for one set, for ten repetitions, ten seconds hold each [18].
Concerning DCE muscles strengthening exercises, they were done in quadruped position with cervical, thoracic and lumbar curves kept in their neutral position. For performance of craniocervical flexion and return to neutral, the participant was asked to do a head-nodding from neutral position into flexion then back, without rotation in upper cervical region. In upper cervical rotation, the participant rotated his/her head as if he/she said no. The movement was limited to less than 40°, so that it focused on craniocervical region especially obliquus capitis superior and obliquus capitis inferior muscles. Extension of lower cervical spine was performed by maintaining the craniocervical region in a neutral position and extending the rest of the cervical spine focusing on the semispinalis cervicis/multifidus muscles [19].

Outcome measures

Visual analogue scale (VAS)

It was used to evaluate pain intensity pre- and post-treatment for both groups (A & B). The VAS is well-known as valid measurement tool for recording pain intensity that can provide wide-acceptance, validity, and reliability estimation of pain intensity. The participant's pain intensity was recorded by using a self-reported score with single handwritten mark placed at one point along the length of a ten cm line ranged from the left side zero score (no pain) to the right side ten score (maximum pain) [20].

Neck disability index (NDI)

It was used to evaluate neck pain and disability pre- and post-treatment for both groups (A & B). It consists of ten questions concerning pain intensity, personal care, lifting, reading, headaches, concentration, work, driving, sleeping, and recreation. Each questionnaire item is ranged from zero (no disability) to five (total disability), with the highest possible score set at fifty. The NDI Arabic version shows a validity and reliability tool for assessment of neck pain and disability in Arabic-speaking patients so, it can be recommended for research and clinical purposes [21].

Statistical analysis

The statistical analysis was done by using statistical SPSS Package program version 25 for Windows (SPSS, Inc., Chicago, IL). Data were screened, for normality assumption test and homogeneity of variance. Normality test of data using Shapiro-Wilk test to test the normal distribution of the study variables. This test showed that demographic data, NDI were normally distributed ($p > 0.05$). But, dependent variable data of VAS were not normally distributed ($p < 0.05$). All these findings were allowed to conduct parametric and non-parametric analysis. Quantitative descriptive statistics including the mean and standard deviation for demographic data, VAS variable and NDI. Quantitative descriptive statistics including the number and percentage for gender. Chi-square test (χ^2-test) to compare between group (A) and group (B) for gender. Paired T-test to compare between pre and post-treatment within group (A) and group (B) for VAS and NDI. Unpaired T-test to compare between group (A) and group (B) for age, VAS and NDI variables. Statistical level all statistical analyses were significant at level of probability less than an equal 0.05 ($p \leq 0.05$).

Results

At baseline, both groups were similar regarding age, gender and all outcome measures ($p > 0.05$) (Tables 1-2).

The VAS showed statistically significant reductions ($p < 0.05$) within the two groups (A & B). The post-treatment comparison of both groups showed a statistically significant reduction ($p < 0.05$) in favour of experimental group (B). Also, there was a greater improvement percentage regarding VAS in experimental group (B) (60.00%) than in control group (A) (35.89%) (Table 2).

The NDI total score showed statistically significant reductions ($p < 0.05$) within the two groups (A & B). The post-treatment comparison of both groups showed a statistically significant reduction ($p < 0.05$) in favour of experimental group (B). Also, there was a greater improvement percentage regarding NDI total score in experimental group (B) (68.30%) than in control group (A) (32.12%) (Table 2).

The NDI subscores showed statistically significant reductions ($p < 0.05$) within control group (A), except the subscores of NDI questions concerned with lifting (Q3), concentration (Q6) and driving (Q8) that showed non-significant differences ($p > 0.05$) within control group (A). Within group (B), there were statistically significant reductions ($p < 0.05$) in all NDI subscores. The post-treatment comparison of both groups showed statistically significant reductions in all NDI subscores ($p < 0.05$) in favour of experimental group (B) (Table 2).

Table 1. Demographic data of participants in both groups

	Group A (n = 20) Mean ± SD	Group B (n = 20) Mean ± SD	p-value
Age [years]	53.00 ± 8.05	52.35 ± 4.71	0.343^{NS}
Gender [n (%)]			
Male	2 (10.0%)	5 (25.0%)	0.212^{NS}
Female	18 (90.0%)	15 (75.0%)	

^{NS} P > 0.05 – non-significant, p – probability

Table 2. The HbA1c and fibrinogen levels for both groups

		Group A (n = 20)	Group B (n = 20)	p value*
VAS	Pre treatment	7.30 ± 1.92	7.25 ± 1.25	0.923^{NS}
	Post treatment	4.68 ± 2.14	2.90 ± 1.55	0.005^{S}
	% of improvement	35.89%	60.00%	
	P value**	0.0001^{S}	0.0001^{S}	

		Group A (n = 30)	Group B (n = 30)	p value*
NDI				
Pain intensity (Q1)	Pre-treatment	3.80 ± 1.11	3.55 ± 1.31	0.519[NS]
	Post-treatment	1.55 ± 0.82	0.95 ± 0.75	0.022[S]
	Improvement%	59.21%	73.24%	
	p value**	0.0001[S]	0.0001[S]	
Personal care (Q2)	Pre-treatment	1.90 ± 0.51	1.50 ± 0.35	0.385[NS]
	Post-treatment	0.70 ± 0.23	0.35 ± 0.18	0.014[S]
	Improvement%	63.16%	76.67%	
	p value**	0.0001[S]	0.0001[S]	
Lifting (Q3)	Pre-treatment	3.65 ± 0.53	3.05 ± 1.60	0.060[NS]
	Post-treatment	3.75 ± 0.37	1.75 ± 0.41	0.0001[S]
	Improvement%	2.74%	42.62%	
	p value**	0.577[NS]	0.001 S	
Reading (Q4)	Pre-treatment	3.08 ± 0.24	2.89 ± 0.36	0.695[NS]
	Post-treatment	2.08 ± 1.16	1.00 ± 0.68	0.003[S]
	Improvement%	32.47%	65.40%	
	p value**	0.026[S]	0.0001 S	
Headaches (Q5)	Pre-treatment	2.85 ± 0.81	2.90 ± 0.24	0.935[NS]
	Post-treatment	1.85 ± 0.49	0.35 ± 0.18	0.0001[S]
	Improvement%	35.09%	87.93%	
	p value**	0.003[S]	0.0001[S]	
Concentration (Q6)	Pre-treatment	1.85 ± 0.56	1.40 ± 0.56	0.370[NS]
	Post-treatment	1.30 ± 0.26	0.30 ± 0.17	0.002[S]
	Improvement%	29.73%	78.57%	
	p value**	0.086[NS]	0.002[S]	
Work (Q7)	Pre-treatment	2.50 ± 0.57	3.10 ± 0.29	0.196[NS]
	Post-treatment	1.90 ± 0.58	1.25 ± 1.00	0.013[S]
	Improvement%	24.00%	59.68%	
	p value**	0.049[S]	0.0001[S]	
Driving (Q8)	Pre-treatment	2.25 ± 0.22	2.75 ± 0.62	0.752[NS]
	Post-treatment	2.50 ± 0.91	1.25 ± 0.95	0.028[S]
	Improvement%	11.11%	54.55%	
	p value**	0.391[NS]	0.010[S]	

		Group A (n = 30)	Group B (n = 30)	p value*
Sleeping (Q9)	Pre-treatment	2.70 ± 0.68	2.95 ± 0.79	0.652^{NS}
	Post-treatment	1.45 ± 0.99	0.65 ± 0.24	0.023^{S}
	Improvement%	46.30%	77.97%	
	p value**	0.002^{S}	0.0001^{S}	
Recreation (Q10)	Pre-treatment	2.35 ± 0.66	2.10 ± 0.61	0.633^{NS}
	Post-treatment	1.20 ± 0.11	0.45 ± 0.28	0.014^{S}
	Improvement%	48.94%	78.57%	
	p value**	0.0001^{S}	0.0001^{S}	
Total Score	Pre-treatment	26.93 ± 9.12	26.19 ± 8.62	0.944^{NS}
	Post-treatment	18.28 ± 6.50	8.30 ± 3.70	0.0001^{S}
	Improvement%	32.12%	68.30%	
	p value**	0.0001^{S}	0.0001^{S}	

** Inter-group comparison; ** intra-group comparison of the results pre- and post-treatment.*
^{NS} p > 0.05 = non-significant, ^{S} p < 0.05 = significant, p – probability

Discussion

The finding of this study indicates that the exercise selection based on precisely assessing patient's neuromuscular control that in turn directs and targets the proposed exercise interventions are the most effective to patients suffering from neck pain and neck functional disability [9].

In the current study, the female patients constituted 90% of the patients recruited in control group and 75% of the patients recruited in the experimental group which is concomitant with Kolenkiewicz et al. [22] who reported that cervical spondylosis is more prevalent in female patients (> 60%) than male patients. Among general population, Lv et al. [3] has reported the prevalence of cervical spondylosis in females (16.5%) was higher than in males (10.5%). Wang et al. [23] justified the higher prevalence of females suffering from cervical spondylosis by hormonal changes during menopause that could contribute to vertebral endplate degeneration, and hence affect intervertebral disk nutrition, ending in spinal degeneration.

The results of the current study showed statistical significant difference between pre- and post-treatment scores of pain intensity levels (P = 0.0001; P < 0.05) measured by VAS, with reduction in the post-treatment pain intensity levels in control group by 35.89% and experimental group by 60.00%. It also showed statistical significant difference in post-treatment pain intensity level between control and experimental group, with P value of (P = 0.005; P < 0.05) and percentage of reduction in pain intensity level in experimental group by 24.11% as compared to the control group.

The improvement in pain intensity level in the experimental group as compared to control group, could be attributed to the restoration of the normal function of the weakened DCF muscles causes by cervical spondylosis and eventually restoration of normal neck mechanics.

The mechanism underlying pain reduction due to application of CSE, could be referred to the stimulation of muscle and joint receptors produced by muscle contraction. Muscle contraction generated from the exercise training performed stimulates mechanoreceptors that include, Golgi tendon organs, muscle spindle, and joints proprioception. These signals stimulate pituitary gland to release endorphins and endogenous opioids [24].

The results of the current study showed statistical significant difference between pre- and post-treatment scores of NDI levels (P = 0.0001; P < 0.05), with reduction in the post-treatment NDI levels in control group by 32.12% and experimental group by 68.30%. It also showed statistical significant difference in post-treatment between control group and experimental group, with P value of (P = 0.0001; P < 0.05) and percentage of reduction in NDI level in experimental group by 36.18% as compared to the control group.

The improved deep neck muscles activity and restored neck mechanics have consequently improved the ability of these muscles to support and control the cervical spine and thereby improving pain perception and decreasing spasm in the cervical paraspinal muscles. The craniocervical flexor-muscle exercise enhances neck functional ability through improving neuromuscular control of the DCF muscles [12], while DCE, multifidus and semispinalis muscles are the main stabilizer of cervical spine. These exercises improves sensorimotor control and neuromuscular function of the cervical spine and hence restoring mechanics of the cervical spine [13].

The improved neck function along with the reduced muscle spasm has been reflected in the form of increased flexibility of neck soft tissues in pain free range. As each of the previously mentioned improved parameters impact functional abilities of the neck, there were noticeable improvement in the neck functional abilities reflected on the scores of the total NDI as well as individual questions of the questionnaire.

Falla et al. [9] conducted his study on females with chronic neck pain, and concluded that, performing a specific training program for the DCF has activated the DCF muscles, especially those with least muscular activation and thus they showed reduction in pain intensity and improvement in neck functional abilities. Although being in agreement with our results, the conduction of their study on females only, imposed a lower rehabilitative yield on the cervical spondylosis population comprised of both genders.

A Positive correlation between DCF muscles activity after training and pain reduction degree has been noted with chronic cervical pain patients [10]. The findings of Falla et al. [11] agrees with the current study. An 8-week active cranio-cervical flexion exercise program was conducted on 46 females with chronic neck pain in comparison to passive exercise program that showed improvement in the motor function and stressed on the concept that the specific active treatment is important for improving motor control of the cervical spine.

Our findings are in agreement with Azadi et al. [25] who showed reduction of pain and neck disability after a 12-week neck, core, and combined stabilization exercise program in elderly patients with chronic non-specific cervical pain.

Neck pain and disability were reduced after applying stability exercises program for three sessions per week, in three phases for 8 weeks on patients with cervical disc herniation. The observed effects could be explained as neck stability exercises have improved static endurance of neck muscles especially DCF muscles [26].

Although being applied as a program of home training for three weeks supervised group exercise, Dusunceli et al. [27] has proved in his study that CSE are better than isometric strengthening and stretching exercises in improving neck pain and disability and increasing neck range of motion (ROM). He used VAS, NDI, Beck depression scale and three planes ROM measurements to investigate the long-term effect of CSE, isometric strengthening and stretching exercises on neck pain, disability and ROM over an extended period of time and the results showed the superiority of the CSE on pain and cervical disability compared with stretching and isometric exercises in addition to physical therapy agents for cervical pain management.

Localized resistance exercises achieve relative isolation of the semispinalis cervicis muscle, which impacts neck pain and function positively in patients with neck pain [28].

Study limitations

The study was limited by extraneous factors that may have interfered with the results of this study, these factors are related to variations in life style between patients as activity level, being working/non-working, ergonomical design of the surrounding environment of participants at home and/or work. Another limitation was the psychological factor of the participants during the period of application of the study.

Conclusion

It was concluded that, the cervical stability exercises have a significant effect on both pain and functional disability in patients with cervical spondylosis.

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Piśmiennictwo/ References

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