Available online at **www.ijmrhs.com**

ISSN No: 2319-5886

International Journal of Medical Research & Health Sciences, 2016, 5, 11:502-508

Investigating the effect of stabilization exercise and proprioceptive neuromuscular facilitation exercises on cross-sectional area of deep cervical flexor muscles in patients with chronic non-specific neck pain

Ghadiri Harati Parisa[1], Asgari ashtiani Ahmadreza*[2], Hosseinifar Mohammad[2], Akbari Asghar[3], Rahnama Leila[4] and Ghiasi Fateme[2]

[1]M.Sc. Student of Physiotherapy, Department of Physiotherapy, School of rehabilitation Sciences, Zahedan University of Medical Sciences, Zahedan, Iran
[2]Assistant Professor, Health Promotion Research Center, Zahedan University of Medical Sciences, Zahedan, Iran
[3]Associate Professor, Health Promotion Research Center, Zahedan University of Medical Sciences, Zahedan, Iran
[4]Assistant Professor, Department of Physiotherapy, University of Social Welfare and Rehabilitation sciences, Tehran, Iran
**Corresponding E-mail: ahmadaskary@gmail.com*

ABSTRACT

The objective of this study was to investigate and to determine the effectiveness of specific Stability Exercises (SE)on the muscles of the neck in comparison with Proprioceptive Neuromuscular Facilitation exercises (PNFE) in the cross-sectional area of deep cervical flexor muscles and to examine the improvement of disability and pain in patients with chronic neck pain. This randomized controlled clinical trial was conducted on 44 patients with chronic neck pain in 2016. The patients were randomly divided into two SE and (PNFE) groups (each containing 22 subjects). The pain of patients was assessed using VisualAnalogScale(VAS) questionnaire(VAS) and the disability was assessed using Neck Disability Index(NDI)questionnaire, and cross-sectional area of deep cervical flexor muscles in the right side was assessed using ultrasonography before treatment training and 8 weeks after the start of training. Treatment program for both groups was 8 weeks (6 sessions per week and two sessions per day) with repetition of specified trainings. Variance analysis, independent t-test, and paired t-test were used to compare results before and after treatment between groups and within groups .The mean pain score in both SE ($P<0.001$) and PNFE ($P<0.001$) groups was declined. Mean NDI in both SE ($P<0.001$) and PNFE ($P<0.001$) groups showed a significant decrease. The mean cross-sectional area of deep cervical flexor muscles of patients in SE group and PNFE group increased while the increase in PNFE group ($P=0.09$) was not significant but in SE group was statistically significant ($P=0.008$).This study revealed that both methods of SE and PNFE in patients with chronic neck pain reduced pain and disability, but SE had better effects. Although cross-sectional area of deep cervical flexor muscles increased in both treatment groups, but the increase in cross-sectional area of deep flexor muscles in SE group was significant.

Keywords: Chronic neck pain, SE, PNFE, Cross-sectional area, Deep cervical flexor muscles.

INTRODUCTION

The pain felt in the area between the occiput condyles and the seventh cervical vertebra is called neck pain [1]. Neck pain experienced for three months or more is called chronic neck pain [2]. Neck pain is a common problem in society that almost 70 percent of people experience this pain during their life [3]. Neck pain usually causes fundamental changes in everyday life. Hence, various treatments are required to decrease this pain [4-6]. For this reason, understanding structures effective in the creation of pain and disability has been important to improve functional status and quality of life of patients in past few decades [7, 8].

Recent researches have emphasized the importance of deep cervical flexor muscles like longus colli and longus capitis in stabilization and controlling cervical vertebrae [9]. Several studies have reported a reduction in endurance and strength of deep cervical flexor muscles in patients with chronic neck pain [10]. Certain muscles become weak in patients with chronic neck pain, which the most common weak muscles are anterior and deep cervical flexor muscles [8, 10-12]. Deep cervical flexor muscle weakness in patients with neck pain is followed by a reduction in the size and thickness of muscle [13]. Falla et al found that neck pain patients often suffer from impaired longus colli muscles and the function of deep cervical flexor muscle is reduced in patients with chronic neck pain [14]. This reduction in function and activity of deep cervical flexor muscles causes changes in size and cross-sectional area of the muscle, and change in the size of muscle is followed by a change in its function [13]. To restore power, flexibility, and strength of muscle and ability to perform daily activities, therapeutic training is one of the most common methods used in rehabilitation for patients with neck pain [4].

Therapeutic training programs vary for the management of neck pains depending on the duration, intensity, and type of training [15]. Some studies have shown that isometric and strength exercises have a positive effect on reducing neck pain [16, 17]. Cervical stabilization exercises have been introduced as a rehabilitation program to reduce pain, increase activity, and prevent re-injury [18-20]. Stabilization exercises activate deep muscles. In addition, these exercises support and control joints of spine leading to reduced pain, reduced recurrence and prevent its chronicity [21]. Another training that is used to deal with neck pain is proprioceptive neuromuscular facilitation exercises, which include several movement patterns to facilitate and correct the movement commands through receiving the message of proprioceptive receptors in muscles. Correction of disrupted patterns causes order and facilitates the transfer of proprioception and correction of muscles and joints status [22]. In a study conducted in this regard, it was found that neck muscle training using proprioceptive neuromuscular facilitation technique provided beneficial results in reducing pain and increasing neck muscle strength compared to traditional treatment in patients with chronic neck pain [23].In previous years, measuring of anterior and posterior neck muscles by using Ultra Sonography [US] technique has been the main subject of many studies [24, 25]. The cross-sectionalarea of deep neck flexor muscles can determine the function of the muscle [26]. Investigating the size and thickness of muscle by US is an observable assessment to examine atrophy or hypertrophy of the muscle. In addition, the muscle performance can be assessed with US [26, 27].

On the other hand, investigation and comparison of stabilization exercises and proprioceptive neuromuscular facilitation exercises on the thickness of the deep cervical flexor muscles have not been investigated so far. Therefore, US was used to measure and assess the cross-sectional area of deep cervical flexor muscles to determine the effect of these exercises on the cross-sectional area of deep cervical flexor muscles. Ultrasonography is a proven method to measure the thickness of the muscle. In addition, US is a non-invasive method with easy access and acceptable repeatability to assess deep muscles. Ultrasonography has been used in the assessment of lumbar musclesa lot, but it has been used less in the evaluation of neck [28]. Ultrasonography can help physiotherapists in the assessment and treatment [24]. We also used US to measure the cross-sectional area of deep flexor muscles and to determine the effect of SE and PNFE on these muscles.

MATERIALS AND METHODS

In this single-blind randomized clinical trial study, 44 patients with chronic neck pain at the age range of 22 to 32 years, who referred to physical therapy clinics affiliated to University of Social Welfare and Rehabilitation sciences, were randomly selected and they were assigned into two groups (each containing 22 subjects). There were 21 females and 1 male in each group. The first group patients were treated using specific neck stabilization exercises, and the patients of the second group were treated using specific proprioceptive neuromuscular facilitation exercises. Patients were unaware of the theory of study and they were informed that the objective of the study was to

determine the difference between these two exercises on the patients with chronic neck pain. The sample size was determined for each group based on a pilot study with the reliability of 95% and test power of 90%. Inclusion criteria of the study included age between 22 to 32 years, neck pain for which doctor has not mentioned certain reason and the pain continued for 12 weeks and more. Patients with protrusion or prolapsed disc along with neurological symptoms, spinal surgery, and certain structural damage in the neck, rheumatic diseases, inflammatory and autoimmune diseases, compressive fractures caused by osteoporosis, spinal stenosis, rheumatoid arthritis, mental illnesses, and pregnant patients were excluded from the study. In addition, patients underwent physiotherapy and therapeutic exercises due to pain in neck and shoulder were also excluded from the study.

Then, patients completed consent form for participation in the study and general questionnaire forbasic information. Patients recorded the levelof neck pain in Visual Analog Scale questionnaire. This scale is sensitive to pain and the information obtained from this questionnaire is valid and reliable (29). Neck Disability Index questionnaire was used to obtain neck disability level of patients. The score zero in this questionnaire indicates a lack of problem and as this score goes up, it indicates an increase in disability level. It is a valid criterion and has acceptable reliability (30). To measure the cross-sectional area of deep neck flexor muscles, ultrasonic ultrasonography device (model S-500 made in Canada) was used. The patients were asked to sleep in supineposition on the bed and put both hands to the sides of the abdomen. Head and neck were placed in neutral and relaxed state and to ensure relaxation of the head and neck, the pressure 20 mm Hg was kept during the measurement by using pressure biofeedback device. This situation was kept during the measurement period and the pressure level was continuously checked by pressure biofeedback device to ensure lack of moving the patient's head and neck. The body of fifth cervical vertebra parallel with hyoid bone was determined with hand and the first transverse line was drawn above it on the right side. Cricoid cartilage arch was drawn as the second transverse line on the right side and scanning was performed between these two lines. To ensure the accuracy of measuring the deep flexor muscles, the patient was asked to contract the muscles. Linear probe perpendicular to long axis of muscle moves from the mid line to outside and cross-sectional area of the muscles is measured. The treatment program in both groups was 8 weeks and treatment training in both groups started after measuring the cross-sectional area of muscle and completing VAS and NDI questionnaires.

Stabilization exercise group: seven neck stabilization exercises were used in this study based on existing attitudes (16, 31). These trainings strengthen the muscles around the neck, especially deep flexor muscles (32-34). The first exercise was performed to activate inferior scapular stabilizers. The second, the third, and the fourth exercises were provided for patients for synchronized contraction of flexors and extensors muscles at the minimal load in the prone position. The fifthexercise was performed to use and strengthen the deep cervical flexor muscles. This exercise is Cranio Cervical Flexion (CCF)exercise provided for patients to improve tonic capacity and performance and to maintain posture of deep cervical flexor muscles (35).In SE group, pressure biofeedback device was used to evaluate the performance of the deep flexor muscles. Being sure that the patient performs the exercise properly, sixth and seventh trainings were provided for patients to increase coordination between the flexor and extensor muscles of the neck.
The procedure of training the exercises was so that patient performed the first to fourth exercise with a minimum craniocervical flexion exercise (biofeedback pressure was 20 mm Hg) in the first week, feedback pressure 22 mm Hg in the second week, and feedback pressure 24 mm Hg pressure in the third week. The increase of feedback pressure was 2 mm Hg per week and this procedure was continued up to sixth week when the pressure reached to 30 mm Hg. In the seventh and eighth weeks, sixth and seventh exercises were given for patients. At the end of eighth weeks, the final assessment was carried out.

SE group program consists of 8 weeks, 6 times a week, two times a day, 10 repetitions each time. Each exercise was performed for 10 seconds and 10 seconds rest was given for patients between each repetition. PNFE group program was so that the patient was lying on his back while his head and neck were out of bed. Then, he was performing the movement pattern of the upper limbs including flexion, adduction, internal rotation of the shoulder joint and upper limb simultaneously with movements of head and neck bending forward and rotation toward the same side. Then, patients performed the second pattern in the form of extension, abduction, internal rotation of the shoulder and upper limb along with extending the head and neck and rotation toward the opposite side for both right and left limbs. In performing upper limb movement patterns, patients were asked to follow the movement of the same hand side with his eyes (23). The number of movements in each pattern was 10 times for both of upper limbs. Movement pattern was repeated 10 times in the first and second weeks, while it was increased to 12 repetitions in the third and fourth weeks, 14 repetitions in fifth and sixth weeks, 16 repetitions in seventh and eighth weeks. At the end of the eighth

week, the final assessment was conducted. Proprioceptive neuromuscular facilitation group program consists of 8 weeks, 6 times a week, two times a day, 10 repetitions in each time. Each exercise lasted 10 seconds and 10 seconds of rest was given for patients between each repetition. SPSS 23 software was used to analyze data. Variance analysis was used to analyze repeated data, to compare the two treatment methods, to compare two groups before and after the treatments, and to investigate their mutual effect. To paired comparison before and after treatment, paired t-test was used and independent t test was used to compare two treatment methods in each of the measured times. The significant level of tests was determined 0.05.

Findings

Demographic characteristics of groups in the study and their comparison are shown in Table 1. According to the data presented in Table 1, the two groups were similar in terms of background variables and these variables could not affect the results of the study as confounding factors.

Table 1: Mean ± SD of quantitative variables measured in the stability and proprioceptive neuromuscular facilitation exercise groups.

Variable	Stabilization exercise group	Proprioceptive neuromuscular facilitation exercise group	P value
Age (year)	26.09±2.42	26.09±2.84	P=0.96
Height (cm)	162.27±5.63	161.68±7.51	P=0.76
Weight (kg)	61.86±9.47	60.09±10.54	P=0.56
BMI	23.42±2.80	22.87±2.43	P=0.49
Pain severity when referring	6.90±1.47	6.45±1.22	P=0.37

Intergroup comparisons for each group: the mean pain measured with VAS showed a significant decrease in both groups (p<0.001). NDI in both groups decreased significantly compared to before treatment (p<0.001) (Table 2). The cross-sectional area of deep flexor muscles in both treatment groups increased compared to before treatment, and this increase was statistically significant in SE group (p<0.001), while it was not significant in PNFE group (p=0.09).

Table 2: Comparison of data before and after treatment of pain, Neck Disability Index and the cross-sectional area of deep flexor muscles in both groups and comparing the results between the two groups after the treatment and the recovery rate between SE and PNFE groups.

Variable	Stabilization training group Mean ± SD			Proprioceptive Neuromuscular Facilitation Exercise group Mean ± SD			Comparing the results between the two groups (P value)
	Before treatment	After treatment	P value	Before treatment	After treatment	P value	
VAS	6.90±1.47	1.09±1.15	P<0.001	6.54±1.22	2.04±1.18	P<0.001	P=0.26
NDI	22±5.14	14.63±4.43	P<0.001	21.68±4.29	16.54±6.18	P<0.001	P=0.85
Cross-sectional area of deep flexor muscles	0.54±0.01	0.52±0.09	P<0.001	0.64±0.018	0.47±0.017	P=0.09	P<0.01

Comparisons between groups: in terms of VAS and NDI, significant difference was not found between SE and PNFE groups, but significant differences were found between the two groups in terms of cross-sectional area of deep cervical flexor muscles. Stability exercises for patients with chronic neck pain were effective in increasing cross-sectional area of deep flexor muscles. Study reports are summarized in Table 2.

DISCUSSION

In 13% of cases, neck pains are chronic [36]. Deep flexor muscle weakness in patients with neck pain reduces their ability to control their vertebrae [14]. Additionally, the weakness of the flexor muscles increases superficial flexor muscle activity and causes forward head posture. In addition, disability and pain in the neck are due to reduced activity of deep flexor muscles [37]. To increase the activity of the deep flexor muscles and to reduce pain and disability in these patients, the best treatment is SE [11]. However, effect of stability exercises is still being investigated in the majority of studies.

Jull et al showed the increased muscle activity of the cervical spine muscles after SE training, especially after CCF exercises in patients with cervico-genic headache [38]. However, Jull did not compare the effectiveness of these trainings with that of PNFE. As a result, we could not state that the effect of Jull's exercises was better for patients with neck pain. In a study measured the cross-sectional areas of anterior and posterior muscles of the neck in healthy

people, it was found that there is a direct correlation between the cross-sectional area of longus Colli and cervical lordosis and it causes stabilization in the cervicalspine [39]. Asgari et al reported the cross-sectional area of longus muscles in patients with chronic neck pain in the stability group more than in the maximal isometric group [40]. This is in agreement with our study, in which the cross sectional area of longus muscles in the stability exercise group is greater.

In the PNFE technique, exercises create neuromuscular reactions through proprioceptive receptors. The patterns of these types of training are in the form of rotational and multi-axial movements or in line with the axis of muscles [41]. These multi-axial movements are better than simple and single-axis movements [42]. In these studies, PNFE were used to increase the range of motion and muscles endurance [21, 41, and 42]. Rezasoltani showed that PNFE method is an effective method in reduction of pain compared to traditional treatment [23]. In this study, PNFE reduced VAS and NDI significantly, while the amount of increase in thickness of deep flexor muscles was not statistically significant.

Generally, the results showed that SE in the treatment of patients with chronic neck pain is better than PNFE. In patients with chronic neck pain, the activity of deep muscles, especially deep flexor muscles, reduces and activity of superficial muscle increases. In a study, it was shown that in deep flexor muscles of the neck, the number of type 2 fibers is greater than the number of type 1 fibers and density of muscle spindles increased [9]. In this study, the cross-sectional area of deep flexor muscles in SE group increased compared to PNFE group. It could be due to increased activity of muscle spindles in these types of training. This study is the first study measured and compared the effect of stability and proprioceptive neuromuscular facilitation exercises on cross-sectional area of deep flexor muscles simultaneously.

CONCLUSION

According to results of this study, SE and PNFE are effective for treatment of patients with chronic neck pain in reducing pain and disability. However, SE play a more important role due to a significant increase in cross-sectional area of deep flexor muscles in the stability of neck in the neutral posture, increasing neck balance, and consequently improved the quality of life during the activity. Results of this study showed that CCF exercises are an effective method to increase the cross-sectional area of deep flexor muscles and functional activities. Therefore, performing these exercises is recommended to improve deep flexor muscles.

Acknowledgement
This paper was derived from a master thesis on physiography. Authors of this paper appreciate for the cooperation of Research Deputy of Medical Science University of Zahedan and professors of Physiotherapy Department in Social Welfare and Rehabilitation Sciences University due to their collaboration in conducting this project and all people participated in this study.

REFERENCES

[1] Cote P, Cassidy JD, Carroll LJ, Kristman V. The annual incidence and course of neck pain in the general population: a population-based cohort study. Pain. 2004;112(3):267-73.
[2] Gomez M, Hildingsson C, Stegmayr B, Toolanen G. Chronic neck pain of traumatic and non-traumatic origin: a population-based study. Acta orthopaedica Scandinavica. 2003;74(5):576-9.
[3] Fejer R, Kyvik KO, Hartvigsen J. The prevalence of neck pain in the world population: a systematic critical review of the literature. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society. 2006;15(6):834-48.
[4] Wolsko PM, Eisenberg DM, Davis RB, Kessler R, Phillips RS. Patterns and perceptions of care for treatment of back and neck pain: results of a national survey. Spine. 2003;28(3):292-7; discussion 8.
[5] Rempel DM, Harrison RJ, Barnhart S. Work-related cumulative trauma disorders of the upper extremity. Jama. 1992;267(6):838-42.
[6] Boden SD, Swanson AL. An assessment of the early management of spine problems and appropriateness of diagnostic imaging utilization. Physical medicine and rehabilitation clinics of North America. 1998;9(2):411-7, viii.
[7] Barton PM, Hayes KC .Neck flexor muscle strength, efficiency, and relaxation times in normal subjects and subjects with unilateral neck pain and headache. Archives of physical medicine and rehabilitation. 1996;77(7):680-7.
[8] Chiu TT, Sing KL. Evaluation of cervical range ofmotion and isometric neck muscle strength: reliability and validity. Clinical rehabilitation. 2002;16(8):851-8.

[9] Boyd-Clark LC, Briggs CA, Galea MP. Muscle spindle distribution, morphology, and density in longuscolli and multifidus muscles of the cervical spine. Spine. 2002;27(7):694-701.
[10] Ylinen J, Salo P, Nykanen M, Kautiainen H, Hakkinen A. Decreased isometric neck strength in women with chronic neck pain and the repeatability of neck strength measurements. Archives of physical medicine and rehabilitation. 2004;85(8):1303-8.
[11] Dusunceli Y, Ozturk C, Atamaz F, Hepguler S, Durmaz B. Efficacy of neck stabilization exercises for neck pain: a randomized controlled study. Journal of rehabilitation medicine. 2009;41(8):626-31.
[12] Gogia PP, Sabbahi MA .Electromyographic analysis of neck muscle fatigue in patients with osteoarthritis of the cervical spine. Spine. 1994;19(5):502-6.
[13] Javanshir K, Rezasoltani A, Mohseni-Bandpei MA, Amiri M, Ortega-Santiago R, Fernandez-de-Las-Penas C. Ultrasound assessment of bilateral longuscolli muscles in subjects with chronic bilateral neck pain. American journal of physical medicine & rehabilitation. 2011;90(4):293-301.
[14] Falla DL, Jull GA, Hodges PW. Patients with neck pain demonstrate reduced electromyographic activity of the deep cervical flexor muscles during performance of the craniocervical flexion test. Spine. 2004;29(19):2108-14.
[15] Chiu TT, Lam TH, Hedley AJ. A randomized controlled trial on the efficacy of exercise for patients with chronic neck pain .Spine. 2005;30(1):E1-7.
[16] Sweeney T. Neck school: cervicothoracic stabilization training. Occupational medicine (Philadelphia, Pa). 1992;7(1):43-54.
[17] Andersen LL, Kjaer M, Sogaard K, Hansen L, Kryger AI, Sjogaard G. Effect of two contrasting typesof physical exercise on chronic neck muscle pain. Arthritis and rheumatism. 2008;59(1):84-91.
[18] Saal JA. The new back school prescription: stabilization training. Part II. Occupational medicine (Philadelphia, Pa). 1992;7(1):33-42.
[19] Stuge B, Laerum E ,Kirkesola G, Vollestad N. The efficacy of a treatment program focusing on specific stabilizing exercises for pelvic girdle pain after pregnancy: a randomized controlled trial. Spine. 2004;29(4):351-9.
[20] Hides JA, Jull GA, Richardson CA. Long-term effects of specific stabilizing exercises for first-episode low back pain. Spine. 2001;26(11):E243-8.
[21] Falla D, Jull G, Hodges P, Vicenzino B. An endurance-strength training regime is effective in reducing myoelectric manifestations of cervical flexor muscle fatigue in females with chronic neck pain. Clinical neurophysiology : official journal of the International Federation of Clinical Neurophysiology. 2006;117(4):828-37.
[22] Knott M, Voss DE. Proprioceptive neuromuscular facilitation: patterns and techniques: Hoeber Medical Division, Harper & Row; 1968.
[23] Rezasoltani AAK, M.%A Tavakoli, A.%A Ahmadipour, A.R. The Comparison of Neuromuscular Facilitation Exercises and Traditional Exercise Therapy Programs in the Treating of Patients with Chronic Non-Specific Neck Pain. Journal of Rafsanjan University of Medical Sciences. 2009;8(1):59-68.
[24] Stokes M, Hides J, Elliott J, Kiesel K, Hodges P. Rehabilitative ultrasound imaging of the posterior paraspinal muscles. The Journal of orthopaedic and sports physical therapy. 2007;37(10):581-95.
[25] Whittaker JL, Teyhen DS, Elliott JM, Cook K, Langevin HM, Dahl HH, et al. Rehabilitative ultrasound imaging: understanding the technology and its applications. The Journal of orthopaedic and sports physical therapy. 2007 . 37(8):434-49.
[26] Rankin G, Stokes M, Newham DJ. Size and shape of the posterior neck muscles measured by ultrasound imaging: normal values in males and females of different ages. Manual therapy. 2005;10(2):108-15.
[27] Hides JA, Richardson CA, Jull GA. Magnetic resonance imaging and ultrasonography of the lumbar multifidus muscle. Comparison of two different modalities. Spine. 1995;20(1):54-8.
[28] Jesus FM, Ferreira PH, Ferreira ML. Ultrasonographic measurement of neck muscle recruitment: a preliminary investigation. J Man Manip Ther. 2008;16(2):89-92.
[29] Melzack R. The short-form McGill Pain Questionnaire. Pain. 1987;30(2):191-7.
[30] Vernon H, Mior S. The Neck Disability Index: a study of reliability and validity. Journal of manipulative and physiological therapeutics. 1991;14(7):409-15.
[31] asgari ashtiani arAe, ismaeil%A torkaman, giti%A amiri, mohsen%A i,. The effects of stabilization and maximum isometric exercises on Tampa Scale Kinsiophobia and Fear Avoidance Belief in chronic non-specific neck pain. Physical Treatments. 2013;3(2):16-23.
[32] Spitzer WO, Skovron ML, Salmi LR, Cassidy JD, Duranceau J, Suissa S, et al. Scientific monograph of the Quebec Task Force on Whiplash-Associated Disorders: redefining "whiplash" and its management. Spine. 1998) 20;5Supp1):1s-73s.
[33] Kay TM, Gross A, Goldsmith C, Santaguida PL, Hoving J, Bronfort G. Exercises for mechanical neck disorders. The Cochrane database of systematic reviews. 2005(3):Cd004250.

[34] Verhagen AP, Scholten-Peeters GG, van Wijngaarden S, de Bie RA, Bierma-Zeinstra SM. Conservative treatments for whiplash. The Cochrane database of systematic reviews. 2007(2):Cd003338.
[35] Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for neck pain. Physical therapy. 2001;81(10):1701-17.
[36] Bovim G, Schrader H, Sand T. Neck pain in the general population. Spine. 1994;19(12):1307-9.
[37] Hanten WP, Lucio RM, Russell JL, Brunt D. Assessment of total head excursion and resting head posture. Archives of physical medicine and rehabilitation. 1991;72(11):877-80.
[38] Jull G, Trott P, Potter H, Zito G, Niere K, Shirley D, et al. A randomized controlled trial of exercise and manipulative therapy for cervicogenic headache. Spine. 2002;27(17):1835-43; discussion. 43.
[39] Mayoux-Benhamou MA, Revel M, Vallee C, Roudier R, Barbet JP, Bargy F. Longuscolli has a postural function on cervical curvature. Surgical and radiologic anatomy : SRA. 1994;16(4):367-71.
[40] AsgariAshtiani arAe, ismaeil%A Mohammadi, Mehdi. Theeffect of stabilization and maximum isometric exercises on cross-sectional area of deep flexor muscles in chronic non-specific neck pain. Physical Treatments. 2014;3(4):52-8.
[41] Hindle KB, Whitcomb TJ, Briggs WO, Hong J. Proprioceptive Neuromuscular Facilitation (PNF): Its Mechanisms and Effects on Range of Motion and Muscular Function. Journal of Human Kinetics. 2012;31:105-13.
[42] Lustig S, Ball T, Looney M. A comparison of two proprioceptive neuromuscular facilitation techniques for improving range of motion and muscular strength. Isokinetics and exercise science. 1992. 154-159