

An Ultrasonographic Investigation of Craniocervical Extensor Muscles in Patients with Chronic Non-specific Neck Pain

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Abstract

Introduction: The purpose of the present study was to measure the thickness and the strength of craniocervical extensor muscles in men with chronic non-specific neck pain and healthy controls. **Materials and Methods:** Fifteen men with chronic non-specific neck pain (CNNP) and 15 healthy controls were participated in this study. The thicknesses of the craniocervical extensor muscles (rectus capitis posterior major(RCPM)) and oblique capitis superior (OCS) in addition to the strength of upper cervical extensor muscles were measured at resting position and during maximal voluntary isometric contraction (MVIC) of craniocervical extensor muscles using ultrasonography device and a dynamometer which was designed for the purpose of study. **Results:** The thicknesses of RCPM and OCS muscles were significantly smaller in the patients group than the healthy controls at resting position and during maximal isometric contraction ($P<0.001$). There was a significant reduced MVIC in patients with CNNP when compared to controls ($P=0.008$). **Conclusion:** The reduced craniocervical extensor muscles strength and thickness in patients with CNNP may be due to pain and reflex inhibition which is originating from cervical neuromusculoskeletal structures. Craniocervical muscles assessments may be needed while evaluating patients with CNNP.

Keywords: Craniocervical, Muscle, Neck, Pain, Strength, Thickness, Ultrasonography

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Introduction

Neck pain is a growing musculoskeletal disorder in our societies (1). 67 to 71% of people sustain neck pain in their lives, without any certain cause (2). Chronic neck pain is one of the most important events that have reported reasons for pain, discomfort and disabilities [3]. Weakness and atrophy of cervical muscles are amongst the most prevalent complications in patients with neck pain (2). It is evident that the weakness of these muscles disturbs cervical spine stabilization and function (3). Among different layers of para spinal muscles, the deeper ones are more involved in providing segmental spinal stability (4). Some evidences indicate the impaired deep muscle function in patients with neck pain (5, 6).

The craniocervical extensors consist of two important small deep muscles (rectus capitis posterior major (RCPM) and oblique capitis superior (OCS) (7) that are attaching to cranium and first and second cervical vertebrae. Their proprioceptive role to control craniocervical movement is highlighted by a quit high muscle spindle density (8). It is claimed that muscles with higher density of muscle spindles are more susceptible to weaken and atrophy than muscles with low spindles density in presence of pain (9, 10). Accordingly, weakness and atrophy of craniocervical extensor muscles is expected in patients with chronic neck pain. In clinical assessments, muscle size measurement is a valuable benchmark for the diagnosis of muscle atrophy (6). Considering non-aggressive, availability, live images, low cost, repeatability, and high

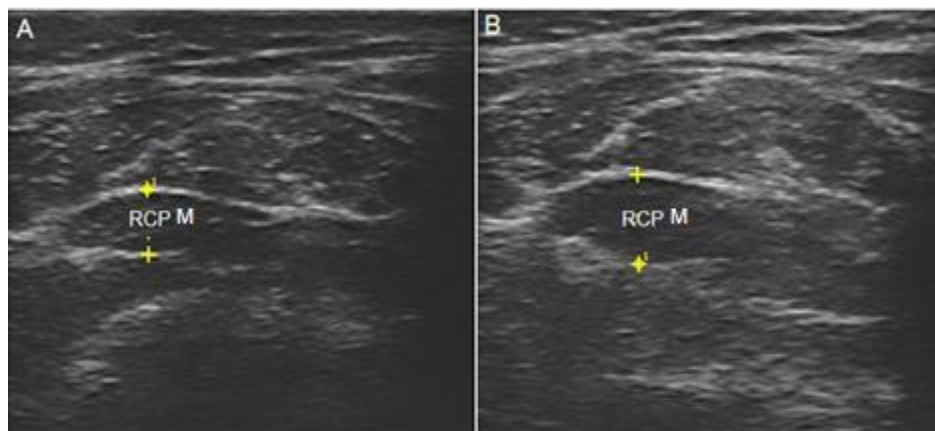


Figure 1. A) The thickness of rectus capitis posterior major (RCPM) muscle at resting position; B) during the maximum isometric contraction of upper posterior cervical muscles

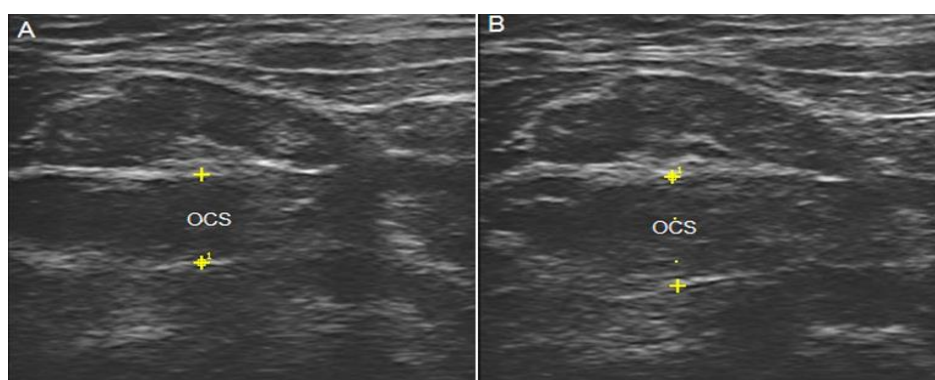


Figure 2. A) The thickness of oblique capitis superior (OCS) muscle at resting position; B) during the maximum isometric contraction of upper posterior cervical muscles

validity of ultrasound imaging, researchers have become more interested in the use of this measurement in examining muscle structures. Reducing cross-sectional area of superficial neck extensor muscles including semispinalis capitis, has been observed in patients with chronic neck pain [6]. Also, deep upper posterior cervical muscles have a fascia bridge to dura mater to regulate dura folding or movement of dura towards spinal cord during head extension (6). Therefore, individuals may experience pain or headaches when these muscles act inappropriately on dura matter (11). Weakness and changes in the length of these muscles may result in instability; lead to the development of ischemic and consequently muscle trigger points (12). The trigger points of these muscles may inflict neck pain, which extend across temporal and occipital areas.

However to the best of our knowledge there is no study that investigates the craniocervical extensor muscles thickness in patients with chronic neck pain. Therefore, this study was conducted to compare the thickness of the rectus capitis and oblique capitis of superior muscles and the strength of upper posterior cervical muscles using an ultrasonography device and a dynamometer in individuals who suffer from chronic nonspecific

neck pain (CNNP) and healthy controls. Accordingly, we hypothesized the lesser thicknesses and lower strength of craniocervical extensor muscles in individuals with CNNP compared to healthy controls.

Materials and Methods

Participants

This case-control study was conducted to measure the thickness and the strength of upper cervical extensor muscles (RCPM and OCS) using ultrasonography and dynamometer, respectively. Fifteen men with CNNP and fifteen healthy controls, from the students and office staff of Shahid Beheshti University of Medical Sciences, were recruited conveniently to the present study. All tests and measurements were performed in the Physiotherapy Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran. The inclusion criteria for the present study were included sustaining neck pain with minimum period of 12-month prior to the study and a pain score of 3 or more on the Visual Analogue Scale (VAS). The healthy controls were included if they had no experience

Table1. Demographic characteristics of all participants (n=30)

Groups	Number	Age (year)	Weight (kg)	Height (m)	BMI (kg/m ²)	VAS (cm)
Patient	15	31.13±5.39 (20.00–39.00)	74.06±13.07 (50.00–94.00)	1.77±0.08 (1.60–1.89)	25.35±3.07 (20.16–29.78)	5.27±1.62 (3.00–8.00)
Healthy	15	28.13±5.34 (21.00–38.00)	78.30±12.33 (55.00–101.00)	1.77±0.07 (1.65–1.90)	24.95±3.08 (20.08–29.82)	

Table2. The mean, standard deviation and range of the thickness of rectus capitis posterior major and oblique capitis superior muscles and the strength of craniocervical extensor muscles at resting position and during maximum voluntary isometric contraction (MVC 100%) in both groups (n=30)

Muscles	Healthy	Patients
Rectus capitis posterior Major (mm) MVC 0%	8.28±1.66 5.52–11.73	5.97±1.33 4.05–8.22
Rectus capitis posterior Major (mm) MVC 100%	12.02±1.90 9.78–15.62	8.06±1.68 5.91–11.51
Oblique capitis superior (mm) MVC 0%	12.89±1.61 10.45–16.27	10.24±1.97 6.45–12.85
Oblique capitis superior (mm) MVC 100%	17.69±2.01 15.00–21.52	13.72±2.51 10.84–18.42
Maximum strength (Kg)	9.47±2.06 5.77–12.29	7.35±2.00 4.56–11.17

of pain in the year prior to the study. Participants with fibromyalgia, myelopathy, cervical radiculopathy, history of vertebral column surgery, osteoarthritis, cervical rib, and cervical whiplash lesion, neck and shoulder exercises in 3 months prior the study and intense physical activity 3 days prior to the study were excluded. All the study procedures were completely explained to volunteers, and then they signed their written informed consent if they wanted to participate in the study. This study was approved by the Ethical Committee of Shahid Beheshti University of Medical Sciences.

Ultrasound imaging

In the present study, an ultrasonography device (Honda 2100, Honda Co., Japan) with a linear array probe (5 cm) and frequency of 7.5 MHz was used for the measurement of craniocervical extensor muscles thicknesses (13). The imaging process was performed while the participants sat on the examination chair at rest and during the maximum contraction of craniocervical extensor muscles. The examiner first looked for the spinous process of the second cervical vertebra, and then moved the probe laterally to determine the first and second cervical vertebrae's lamina. While recording the first cervical vertebra's lamina, the probe was moved upwards and downwards to determine the margins of rectus capitis posterior major muscles (Figure 1). Then the fascial margins of oblique capitis superior muscle were recognized by moving the probe towards lateral margin (Figure 2). The maximum length of muscle fascicles was considered along anterior-posterior direction to record the muscle thickness.

Muscle strength measurement

Participants were instructed to sit on a chair with the head and neck in neutral, and the trunk in upright positions. Thorax and

pelvic girdle were respectively fixed to the chair by 2 belts at the levels of scapular spine and iliac crest to prevent the influence of the contraction of trunk muscles during the test. (14). In all measurements, both hands were on thighs and arms were close to the body, hips were in adduction and 90 degrees of flexion (Figure 3). A custom made device consisting of a load cell was used to measure the maximum isometric strength of craniocervical extensor muscles. The method of measurements and the accuracy of the device have been reported in our earlier study (14). The subjects were asked to push their chin against the load cell as strong as possible and hold it for 5 second. The test procedure was conducted 3 times with one minute apart; the maximum recorded was used for data analysis. In order to get familiar with the test procedure, participants were instructed to perform the craniocervical extension task 2-3 times with submaximal strength.

The offline measurement of the RCPM and OCS muscle thicknesses at rest and at the maximum states of isometric contraction of the upper cervical extensor muscles was performed by the Sonosynch software. The software enabled to pick up and store the data of images of the RCPM and OCS and the strength of craniocervical extensor muscles in a synchronized format with sampling rate of 20 per seconds (15).

Statistical analysis

The descriptive indices including: mean, standard deviation and range were calculated. Data normality was examined using one-sample Kolmogorov-Smirnov test. A parametric test (independent t-test) and its equivalent non-parametric test (Mann-Whitney) were employed. The statistical analyses were computed using SPSS for windows version 18. Data analysis was done at the significance level of $P < 0.05$.



Figure 3. The subjects' position to measure the strength of upper cervical extensor muscles

Results

The means and standard deviations and range of anthropometrics characteristics of all participants have been presented in Table 1.

Table 2 presents the mean, standard deviation and range of the thicknesses of RCPM and OCS muscles at resting position and during maximum voluntary isometric contraction of craniocervical extensor muscles in both groups. There was a significant difference between-groups in terms of the RCPM and OCS muscles thickness at both resting position and during maximum isometric contraction ($P < 0.001$) indicating significantly smaller muscle thickness in the CNNP group than the controls both at resting position and during maximum contraction of craniocervical extensor muscles.

Moreover, the maximum isometric strengths of craniocervical extensor muscles was significantly more in healthy controls compared to individuals with CNNP ($P = 0.008$).

Also the thickness of both muscles was significantly different between two states of muscles at rest and during maximum voluntary isometric contraction ($P < 0.01$).

Discussion

The present study indicated that the thicknesses of craniocervical extensor muscles at resting position and the maximum isometric strength were significantly lower in men with CNNP than healthy men. Fernandez *et al.* investigated the morphology of neck extensor muscles in women with chronic tension-type headaches using MRI. The authors found a significant rectus capitis and oblique capitis muscle thickness reduction in women with headache (16). Fernandez *et al.* also investigated the relationship between the thicknesses of rectus capitis muscles with number of active trigger points. In their study the thicknesses of rectus capitis muscles were measured using MRI. The authors reported muscle atrophy minor in the rectus capitis in association with active trigger points (17).

Rezasoltani *et al.*, Javanshir *et al.* and Hides *et al.* investigated the cervical semispinalis capitis, cervical longus coli, and cervical multifidus muscles and reported smaller muscle size in patients with neck pain than the controls (6, 18, 19). Pain and muscle discomfort may be a possible reason for inhibiting the muscle activity and it is reasonable to expect muscle weakness and atrophy in the presence of chronic pain. Therefore, the reduced craniocervical extensor muscle thickness which observed in the present study might be resulted from pain and reflex inhibition. We also investigated the MVIC of the craniocervical extensor muscles in both patients with CNNP and healthy controls. Our findings demonstrated lower MVIC in CNNP group than controls, and emphasized the pain and weakness of these muscles in individuals with CNNP. Supporting the findings of this study, several studies have shown that the isometric strength of cervical muscles in patients with chronic pain is significantly lower than that in the healthy people (3, 16, 19, 20).

The rectus capitis posterior major is known as the greater posterior rectus capitis and comprise the postero superior border of the suboccipital triangle. It originates from tip of the spinous process of the axis (C2) and inserts in to the lateral part of the inferior nuchal line of occipital bone. It functions as extension and rotation of head (7). The oblique capitis superior originates from the transvers process of C1 and inserts into occipital bone. It functions as head extensor.

The rectus capitis major (RCM) lays is just below the intermuscular fascia of semispinalis capitis. There is oblique capitis superior muscle lateral to RCM. Both muscles were evaluated while they were at rest and during MIVC. The level of expansions or contractibilities of these two muscles were lower in patients than controls. These two muscles are close to each other and can be viewed in one image. They provide a strong lever arm to extend

head on neck. The functions of both muscles are in line of head and neck extension. They actively participate in different pattern of every head and neck movement. Therefore, they would be affected or influenced by any dysfunction arisen from the other cervical structures.

Conclusion

The present study showed that the thickness of RCPM and OCS muscles decreases in men with CNNP compared to healthy controls. In addition, craniocervical extensor muscles were weaker in men with neck pain than healthy men. The lower thickness and strength of craniocervical extensor muscles may be due to pain sufferance, inhibitory reflexes and changes in activation pattern of neck muscles in patients with CNNP. Taking all findings together, craniocervical extensor muscles should not be missed in evaluation and rehabilitation programs of patients with CNNP. As a result, strengthening of this group of cervical muscles should be taken into consideration in rehabilitation programs.

Conflict of interest:

None

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Authors' contributions:

All authors made substantial contributions to conception, design, acquisition, analysis and interpretation of data.

References

- 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*. 2006;15(6):834-48.
- Picavet H, Schouten J. Musculoskeletal pain in the Netherlands: prevalences, consequences and risk groups, the DMC3-study. *Pain*. 2003;102(1-2):167-78.
- Chae SH, Lee SJ, Kim MS, Kim TU, Hyun JK. Cervical Multifidus Muscle Atrophy in Patients with Unilateral Cervical Radiculopathy. *Journal of the Korean Academy of Rehabilitation Medicine*. 2010;34(6):743-51.
- Panjabi M, Abumi K, Duranceau J, Oxland T. Spinal stability and intersegmental muscle forces. A biomechanical model. *Spine*. 1989;14(2):194-200.
- Fernández-De-Las-Peñas C, Albert-Sanchís JC, Buil M, Benitez JC, Albuquerque-Sendín F. Cross-sectional area of cervical multifidus muscle in females with chronic bilateral neck pain compared to controls. *Journal of orthopaedic & sports physical therapy*. 2008;38(4):175-80.
- Rezasoltani A, Ali-Reza A, Khosro K-K, Abbas R. Preliminary study of neck muscle size and strength measurements in females with chronic non-specific neck pain and healthy control subjects. *Manual therapy*. 2010;15(4):400-3.
- Menezes AH, Traynelis VC. Anatomy and biomechanics of normal craniocervical junction (a) and biomechanics of stabilization (b). *Child's Nervous System*. 2008;24(10):1091-100.
- Chan Y, Kasper J, Wilson V. Dynamics and directional sensitivity of neck muscle spindle responses to head rotation. *Journal of neurophysiology*. 1987;57(6):1716-29.
- McPartland JM, Brodeur RR, Hallgren RC. Chronic neck pain, standing balance, and suboccipital muscle atrophy--a pilot study. *Journal of manipulative and physiological therapeutics*. 1997;20(1):24-9.
- Mockford M, Caulton JM. The pathophysiological basis of weakness in children with cerebral palsy. *Pediatric Physical Therapy*. 2010;22(2):222-33.
- Dean N, Mitchell B. Anatomic relation between the nuchal ligament (ligamentum nuchae) and the spinal dura mater in the craniocervical region. *Clinical Anatomy: The Official Journal of the American Association of Clinical Anatomists and the British Association of Clinical Anatomists*. 2002;15(3):182-5.
- Fernández-de-Las-Peñas C, Cuadrado M, Pareja J. Myofascial trigger points, neck mobility and forward head posture in unilateral migraine. *Cephalalgia*. 2006;26(9):1061-70.
- Bokaei F, Rezasoltani A, Manshadi FD, Naimi SS, Baghban AA, Azimi H. Comparison of cervical muscle thickness between asymptomatic women with and without forward head posture. *Brazilian journal of physical therapy*. 2017;21(3):206-11.
- Bokaei F, Rezasoltani A, Manshadi FD, Naimi SS, Baghban AA, Azimi H. Comparison of isometric force of the craniocervical flexor and extensor muscles between women with and without forward head posture. *CRANIO®*. 2016;34(5):286-90.
- Rahnama L, Rezasoltani A, Khalkhali-Zavieh M, Rahnama B, Noori-Kochi F. Reliability of new software in measuring cervical multifidus diameters and shoulder muscle strength in a synchronized way; an ultrasonographic study. *Brazilian journal of physical therapy*. 2015;19(4):279-85.
- Fernandez-de-Las-Penas C, Bueno A, Ferrando J, Elliott J, Cuadrado M, Pareja J. Magnetic resonance imaging study of the morphometry of cervical extensor muscles in chronic tension-type headache. *Cephalalgia*. 2007;27(4):355-62.
- Fernández-de-las-Penas C, Cuadrado ML, Arendt-Nielsen L, Ge H-Y, Pareja JA. Association of cross-sectional area of the rectus capitis posterior minor muscle with active trigger points in chronic tension-type headache: a pilot study. *American journal of physical medicine & rehabilitation*. 2008;87(3):197-203.
- Javanshir K, Mohseni-Bandpei MA, Rezasoltani A, Amiri M, Rahgozar M. Ultrasonography of longus colli muscle: a reliability study on healthy subjects and patients with chronic neck pain. *Journal of bodywork and movement therapies*. 2011;15(1):50-6.
- Hides J, Stokes M, Saide M, Jull G, Cooper D. Evidence of lumbar multifidus muscle wasting ipsilateral to symptoms in patients with acute/subacute low back pain. *Spine*. 1994;19(2):165-72.
- Silverman JL, Rodriguez AA, Agre JC. Quantitative cervical flexor strength in healthy subjects and in subjects with mechanical neck pain. *Archives of physical medicine and rehabilitation*. 1991;72(9):679-81.