

# Investigation of the Strength and Thickness of Upper Posterior Cervical Muscles in Women with Tension Headache

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## Abstract

**Introduction:** In the etiology of tension type headache, the weakness of the upper posterior cervical muscles is associated to myofascial pain in cranio-cervical area. The aim of this study was to compare the strength and the thickness of the upper posterior neck muscles in women with chronic tension type headache and healthy control. **Materials and methods:** The strength and the thickness of upper posterior neck muscles were measured in 33 women (16 women with chronic tension type headache and 16 healthy controls). The strength of the upper cervical extensor muscles and the thickness of semispinalis capitis, splenius capitis, rectus capitis posterior major and oblique capitis superior muscles were measured by a custom made isometric device and a real-time ultrasonography machine. Pain was assessed by a visual analogue scale. **Results:** The strength of the muscles was significantly lower in patients with chronic tension type headache than the control group ( $P<0.001$ ). Only, the thicknesses of rectus capitis posterior major and oblique capitis superior muscles were significantly smaller in patients compare to the healthy controls ( $P<0.001$ ). A statistical negative correlation had been found between the levels of pain and the strength of upper posterior neck muscles ( $r=-0.65$ ,  $P=0.006$ ). **Conclusion:** The results have indicated that rectus posterior major and oblique capitis superior muscles may be weaker in patients with chronic tension type headache than controls. The results may be useful when evaluating the patients with chronic tension type headache by means of the level of upper cervical muscle strength and the muscle thickness measurements.

**Keywords:** Strength, Thickness, Tension Chronic Headache, Upper Posterior Neck Muscles

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## Introduction

Tension type headaches are the most common type of headaches which nearly up to 78 percent of the population suffers from it [4, 32, 58]. The headache occurs more in women and young people compared to men and the elderly [2, 5, 8]. Most headaches are benign and transient and some other affects the person's abilities. According to International Headache Society (IHS), headaches are divided into two categories: primary and secondary. Primary headaches include migraine and tension type headaches. Secondary headaches are those which have been caused by other disorders, such as brain tumors, vascular

diseases and temporo-mandibular joint diseases [1, 4]. It is a recurrent headache that lasts from a few minutes to a few weeks. The type of pain is usually a pressure one with low to moderate intensity and two-sided, and it is not worsened by usual physical activities [9, 32, 57]. Tension type headache makes the life full of hardship, reduces workdays, decreases quality of life, and imposes significant costs to health care [11, 44].

Based on the IHS classification, tension type headache is also divided into two types of chronic and periodic headaches [4, 9, 32, 58]. Periodic headaches are more prevalent [9, 30, 32, 58] which are imposing a significant impact on work performance, home chores and outdoor activities [58]. The chronic tension

type headache is less common [9, 58]; but it has a greater impact on individuals and society and affects fewer people than the periodic type [58]. Although tension type headache is the most common type of headache, the information that regarding its pathophysiology is limited [31], so that a simple and unified pathophysiology mechanism cannot be expected for tension type headaches and tension type headaches mechanism is likely to be multifactorial. Thus, in general, peripheral and central factors are proposed in pathophysiology of tension type headaches [3, 31, 57].

It has been pointed out that peripheral mechanisms can contribute to episodic headaches [3, 31, 57], whereas segment central sensitization and disorder in adjustment of afferent stimuli are involved in the pathogenesis of chronic tension type headaches. The type of headache from episodic to chronic may also be changed from myofascial tissue in long-term by the existence of pain stimuli [32]. Myofascial pains may play an important role in the etiology of tension type headache [17]. Myofascial pain syndrome may happen because of the existence of trigger points in the neck muscles. Among the neck muscles, active trigger point may be developed in posterior sub-occipital muscles and produced local and referred pain to occipital and temporal areas. The pain can be revealed on both sides or appears as a two-sided headache. Posterior sub-occipital muscles are four small muscles which are attached to the first and second cervical vertebrae. The function of these muscles is to extend throughout the posterior of the head. In addition, they have an important role in the stability and control of cranium movement on the first and second vertebrae. They also make a person to see straight forward. In people with forward head posture, trigger points, pain and muscle atrophy may be happened in the upper cervical posterior muscles [10]. As a result of pain, muscles atrophy which is common in musculoskeletal disorders may be occurred in patients with chronic tension type headache [18]. In 2008, Fernandez et al. reported that the thickness of the rectus capitis muscles was decreased in women with chronic tension type headache compared to healthy ones [19].

On the other hand, it has been reported that sub-occipital extensor muscles had more muscle spindles when they are compared to other neck extensor muscles [10]. The higher density of muscle spindles in upper posterior neck muscles may make them to function as the proprioception monitors of the upper part of the cervical spine. The output of proprioception of the muscles may be reduced by the pain, weakness and atrophy of these muscles [59].

Since pain, muscle atrophy, and weakness may occur simultaneously or subsequent to each other, neck upper

posterior muscles may also suffer from muscle weakness in tension type headaches. Assessment of thickness and strength of muscles is a valuable method to determine the healthy or unhealthy conditions of the muscle [56]. Ultrasonographic assessment of muscle thickness is a kind of objective measurement which can help in evaluating atrophy or hypertrophy of muscles and indirectly is useful in estimating muscle strength [26, 29, 56]. Ultrasonography of deep cervical and lumbar muscles has been recently attracted the researchers' notice [20, 25, 50] but researches about upper cervical muscles are very limited. Different studies were held using MRI for measuring the cross-section area of cervical muscles in persons with chronic tension type headache or whiplash injury and they were reported the decreased cervical muscles cross section area [16, 19].

Among the few studies, only one study has been dealt with investigating the reliability of ultrasonography method in determining thickness of sub occipital muscles [39]. The aim of this study was to compare the strength and thickness of the neck upper posterior muscles in women with tension type headache and the healthy ones via ultrasonographic assessment besides using force measurement devices.

## Materials and Methods

This study is an observational case-control study on 33 women aged 18 to 35 in a group of 16 patients with chronic tension type headache and a group of 17 healthy women. The sample was selected based on inclusion and exclusion criteria by a neurologist. The study inclusion criteria for patients with chronic tension type headache have been included experience of headaches for more than three months and at least 15 days per month [19], have not neck and shoulders training program in the last three months [20], absence of nausea during headache, have not physiotherapy during the study, stable disease condition and lack of underlying chronic disease, the headache is not worsened with exercise, no headache in healthy subjects, no neck pain in patients and healthy subjects, no dizziness and vestibular disorders in healthy subjects, no pregnancy, no arthritis, absence of any neurological and degenerative disease, no muscle myopathy, lack of muscular torticollis [19], no reciprocating injury, lack of specific structural damage in the neck (fracture, dislocation, lack of fixator, lack of visual and hearing impairment,  $20 < \text{BMI} < 30$ , no use of drugs, no use of prophylactic drugs during study [19]. Exclusion criteria have been included lack of cooperation, and unforeseen problems during study.

**Table 1.** The anthropometrics characteristics of all subjects (n=32)

Group	Height (Cm)	Weight(Kg)	BMI
Healthy	161.29±13.81	59.49±9.06	23.23±5.23
	112.00-174.00	43.00-74.00	18.00-41.45
Patient	161.40±6.80	57.50±5.64	22.15±2.56
	148.00-172.00	50.00-67.70	18.10-26.12

**Table 2.** The mean (SD) and range of the thickness and the strength of upper cervical extensor muscles

Muscles and strength	Patient group	Healthy group	P-value
Semispinalis capitis (mm)	13.24±0.78	12.74 ±0.88	0.12
	11.87-14.72	11.20-14.43	
Splenius capitis (mm)	4.50±0.51	4.73 ±0.37	0.16
	3.67-5.60	4.23-5.23	
Rectus capitis posterior major (mm)	4.28±0.81	5.62±0.63	< 0.001
	3.19-5.60	4.10-5.57	
Oblique capitis superior (mm)	7.65±1.10	10.09±0.93	< 0.001
	6.42-10.6	8.01-11.21	
Maximum isometric strength of upper cervical extension (N)	30.46±7.8	59.53±6.4	0.02
	11.28-46.11	40.22-62.78	

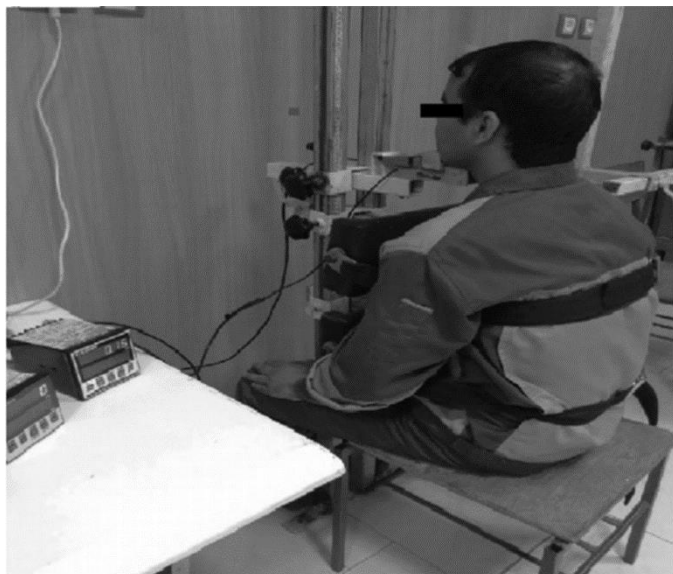
On the day of the test, after completing the consent form, participants filled background information form including history of exercise training. Weight and height were measured by routine measurement tools. Pain severity was identified by Visual Analogue Scale (VAS).

A force measurement device was designed in order to measure the strength of upper cervical muscles [6]. The method and the reliability of the device have been reported in our earlier study [7]. But briefly, the subjects were asked to sit on a chair while their trunk and pelvis were supported by the back of the chair and two straps which one was placed around the pelvic and the other around the shoulder. The knees were slightly bent and heels were put on a stool with 15 cm height that was supposed to prevent compensation movements of the lower extremities; the hands were on thighs with the palms of the hands upward. For warm up, the subjects were asked to flex their cervical spine and stretch the neck extensor muscles for ten times and hold it for ten seconds at the end of range of motion. Subjects were performed the upper cervical extension without temporomandibular joint movement, several times and at sub-maximal intensity, to prepare for principal test.

After preparation, the subjects were asked to perform three Maximum Voluntary Contractions (MVC) of upper cervical extensor muscles lasted for 10 second. During the test, subjects were received feedback by the values shown on the monitor which was placed just in front of them. There was two minutes rest between attempts. If the amount of force among three tests was different by ten percent, another test was conducted [20, 39].

Imaging was done by Honda ultrasonography device (HS-2100, Honda Co., Japan) with 7.5 MHz frequency and a 5 cm linear array probe. Images were taken from right upper posterior cervical muscles (semispinalis capitis, splenius capitis, rectus capitis posterior major, oblique capitis superior muscles) while subjects' heads and necks were kept in neutral position. The maximum distance between anterior and posterior muscle border was regarded as anterior-posterior dimension.

Independent t-test was computed to compare the results between the groups. Pearson correlation test was used to investigate the relationship between pain severity and upper cervical extension force; the raw data were analyzed using SPSS software program for windows (version 16). Statistical significant was set at  $P < 0.05$ .



**Figure 1.** The subject's position during the force measurement of the upper cervical muscles

## Results

There were 16 subjects on each group, the mean and standard deviation of age in the healthy group was  $26.24 \pm 3.649$  and it was  $28.44 \pm 4.305$  in the patients' group. The difference in terms of age was not significant between two groups. The anthropometrics characteristics of all subjects are provided in Table 1.

Two groups had no significant difference in terms of BMI comparison. There was a significant difference in upper cervical extension force between the two groups of women with chronic tension type headache and healthy women ( $P = 0.021$ ). The force was greater in healthy women than the patients (Table 2). Each muscle thickness was divided by the strength of the upper cervical extensor muscles by calculating the normalization in this study. Comparison of normalization of data between the two groups showed a significant difference ( $P < 0.001$ ) in all of the studied muscles.

The thickness of semispinalis capitis muscle and splenius capitis was not significantly difference between two groups. But rectus and oblique capitis muscles' thickness were significantly different between women with chronic tension type headache compared to the healthy controls ( $p < 0.001$ ) (Table 2).

The mean and standard deviation of VAS index measurement was  $6.50 \pm 1.41$  in the patient group (ranged between 4 to 9). The result of the correlation between VAS and the maximum isometric strength of upper cervical extensor muscles showed an inverse significant relationship between these two variables ( $r = -0.65$  and  $P = 0.006$ ).

## Discussion

Weakness is common in musculoskeletal pains, in conditions such as myofascial trigger points, fibromyalgia, chronic fatigue syndrome, temporo-mandibular disorders and back pain [22, 23]. It has been reported that long term mechanical low back pain leads to muscle atrophy and increases dynamic fatigue [43]. Mbada et al. (2011) indicated that pain is a major disorder in long-term low back pain which leads to reduce the motion, stiffness, and muscle atrophy. This issue, like a vicious cycle, may cause pain and return of symptoms similar to the situation of spinal deformity. Pain results in muscle protective function, malfunction of spinal muscles and ultimately lead to muscle atrophy that results in muscle weakness. Therefore weakness may be secondary to inhibition due to painful stimuli [22, 23]. In painful condition, musculoskeletal system can be pathophysiologically affected by any individual muscle performance [24]. In long term, muscles may also be weakened due to maladaptive variations in movement patterns activities. Muscles with active trigger points get tired earlier than other healthy muscles and show a reduction and also poor coordination in motor units' activities. Overused muscles get short during time. The excessive use finally leads to Ischemia and damage to muscle fibers and consequently weakens the muscles [25].

Tension type headache is the most common and frequent episodic type of headache which occurs more in women and young people compared to men and the elderlies. However, whether the headache results in weakness and atrophy of upper posterior neck muscles or a reverse process occurs, is still unknown. Ultrasonography with the capability of measuring muscle dimensions could be an appropriate diagnostic apparatus to investigate muscle performance in static and dynamic situation in real time [33, 37]. Because of the special complexity of the cervical muscles, using a real time ultrasonography to detect dimensional changes of these muscles could be helpful in evaluating the function of an individual cervical muscle [55]. It is a reliable and valid method to measure cervical muscles dimensions [39, 53].

Rezasoltani et al. (2002) reported that one of the possible ways to determine the relationship between thickness and force production of a muscle is to measure the thickness while muscle is contracting and they believed that measuring force and thickness simultaneously could result in better understanding of muscle performance especially those with complex structure like cervical muscles. They reported that there was a significant correlation between semispinalis capitis muscle strength and it's



thickness during isometric contraction of cervical extension, using ultrasonography and dynamometer devices [55].

This study aimed at investigating the strength and thickness of upper posterior cervical muscles in women with chronic tension type headache and comparing it with healthy ones. The results of this study showed that only the thickness of rectus capitis posterior major and oblique capitis superior muscles were decreased in patients with chronic tension type headache.

Results also showed a significant difference in terms of strength between the women with chronic tension type headache and the healthy women who have more power in comparison to women who have tension type headache. This result is consistent with the findings of Fernandez et al. [17], Madsen et al. [27], and Oksanen et al [26] in patients with tension type headaches. It is also consistent with the results of Verbunt et al in patients with back pain [28], Ylinen et al in patients with neck pain [29], and Prins et al in patients with Patello-femoral joint pain [30].

It has been reported that, patients with tension type headache have forward head posture and more trigger points in their sub-occipital muscle than controls [17]. Painful inputs of these trigger points may continuously affect trigeminal nerve nucleus too. In addition, with greater forward head posture, the contraction of the sub occipital muscles may be varied and consequently more nociceptive inputs converged on the trigeminal nerve and increased the symptoms. Although the sub-occipital muscles contraction is responsible for activating the trigger points in connection with forward head posture and, the forward head posture may be due to tension type headache, but, this anti-pain posture attempts to reduce pain.

## Conclusion

According to the results of this study, the upper posterior neck muscles were weaker in women with chronic tension type headache compared to healthy women. Also, the muscle strength has an inverse relation with the intensity of pain. Measuring the strength of upper posterior muscles has been recommended in patients with chronic tension type headache to identify the causes of these headaches, and apply appropriate preventive strategies to prevent it.

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## Authors' contributions:

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

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