



# Comparison of the effects of muscle stretching exercises and cupping therapy on pain thresholds, cervical range of motion and angle: a cross-over study

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**Objective:** Computers and smartphones have become a necessity for modern people, and the use of these things in an inappropriate position has increased the number of people who complain about neck problems. The purpose of this study was to compare the changes of cervical angle, range of motion (ROM) and pain threshold according to the McKenzie stretching and dry cupping therapy.

**Design:** Cross-over design.

**Methods:** We included 12 male and 6 female college students in their twenties, and conducted a pre- and post-test to evaluate the changes of each variable after the application of the McKenzie stretching and dry cupping therapy.

**Results:** Neither the cervical spine angle nor the turtle neck angle showed any change in both the McKenzie stretching and the dry cupping treatment. In the McKenzie stretching, the pain threshold decreased, and the ROM of the cervical spine increased in all directions but there was no significant difference. The pain threshold was increased in the dry cupping treatment, and the ROM of the cervical spine was significantly increased in all directions ( $p < 0.05$ ). Comparisons of the McKenzie stretching and cupping treatment showed that the cupping treatment produced significantly greater pain thresholds and improvements in ROM of the cervical spine than the McKenzie stretching technique ( $p < 0.05$ ).

**Conclusions:** Cupping treatment is more effective in improving ROM of the cervical spine and pain thresholds than the McKenzie stretching technique. In the future, cupping treatment will be one of the treatment options for pain and ROM impairments of the cervical spine.

**Key Words:** Articular, Cupping therapy, Muscle stretching exercise, Range of motion, Shoulder pain

## Introduction

Computers and smartphones have become an important necessity for modern people. According to the Pew Research Center, the use of computers and smartphones average to approximately 5.1 hours during the weekdays and 5.6 hours during the weekends. Incorrect postures during long hours of use of smartphones and computers cause musculoskeletal problems [1]. The prolonged use of the computer and smartphone also promotes the repeated use of certain muscles and

frequently causes damage and tension in the muscles of the neck and shoulders as a result of cumulative damage. Repeated cumulative trauma on the neck and shoulder may cause a specific musculoskeletal disorder, including turtle neck, which causes weakness of the middle and lower parts of the trapezius and rhomboid muscles, creating shoulder retraction and causing shortening of the main muscles of the chest and neck extensors. It also increases the activity of the upper trapezius, which causes most patients to suffer from excessive muscular pain [2]. Neck pain is one of the most

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frequently occurring diseases in everyday life [3]. The normal curvature of the spine maintains good posture with a uniform distribution of body weight, minimizing the burden on each joint, and preventing tension and deformation of the soft tissue. It also distributes the body weight evenly, minimizing the burden on each joint, and prevent tension and deformation of the soft tissue [4]. Recently, the development of the biomechanical concept of the spine has increased the importance of the curvature itself in the normal functioning of the vertebrae as well as the importance of vertebral curvature in relation to various disease states of the vertebrae [5]. Using a smartphone and a computer for a long time in the wrong posture leads to a posture that allows the head and shoulder to move forward. Epidemiologic studies have shown that the posture that a forward protrusion of the head and the shoulder is the most common prevalence of spinal diseases in children and adolescents [6].

Flexibility and range of motion (ROM), as well as the lordosis of the cervical vertebrae, are very important factors in sports, rehabilitation, and musculoskeletal pain [7]. Flexibility can be defined as the ability of the muscle to stretch and move one or more joints as far as the ROM, which is an essential component of normal biomechanical function [7]. Because of this, accurate measurement of the ROM of the cervical spine can be an objective indicator of neck disease [8].

The McKenzie stretches for the neck are expected to have an effect on the correction of the posture of the cervical spine, and the treatment program with exercise can improve the patient's function and reduce stress and chronic myalgia [9].

Cupping therapy is an ancient treatment that applies suction onto the skin. Historically, cupping therapy has been used not only for musculoskeletal disorders but also for many diseases such as gynecology, ear diseases, and lung diseases [3]. Applying cupping therapy increases the threshold for immediate pressure pain, accelerates the removal of waste and toxins from the body, and stimulates metabolism, resulting in vasodilation and devoted blood circulation. This has been shown to be effective for muscle relaxation and chronic neck pain [10].

Previous studies have scientifically proved the effects of McKenzie stretching and cupping. However, there have been many studies to investigate changes in cervical spine angles and pain thresholds with the McKenzie stretching, and cupping therapy has been studied in terms of changes in angle and ROM of the cervical spine. There are a lack of studies comparing the McKenzie's stretch and the cupping therapy to the cervical spine. The purpose of this study was

to investigate the differences in the angle of the cervical spine and the pain thresholds around the cervical vertebrae by applying the McKenzie exercise and the cupping therapy.

## Methods

### Subjects

Participants in this study were 12 males and 6 females students in their twenties who were studying at Sahmyook University. The subjects who participated in the experiment were selected as those who voluntarily agreed to the experiment and those who had no restrictions on the ROM of the neck, those without disk disorder, and those who had no open wounds at the sites where the cupping therapy was applied.

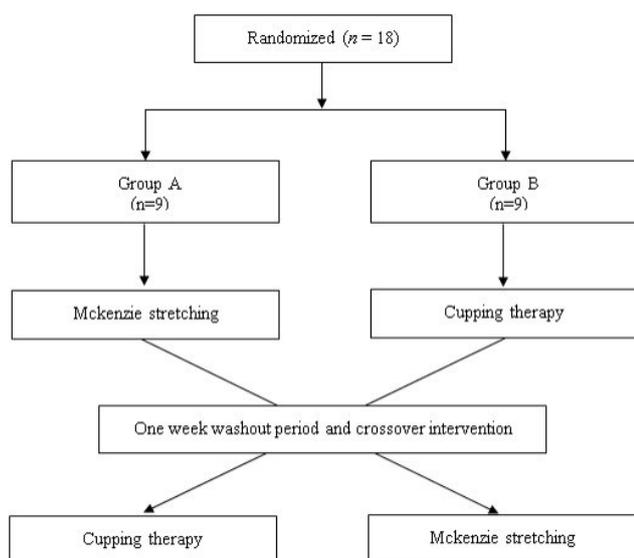
All protocols and procedures were approved by the institutional review board of Sahmyook University (IRB No. 2-1040781-AB-N-01-2016088HR), and all of the participants signed a statement of informed consent.

### Intervention

In this experiment, a cross-over design was used in which each treatment was sequentially applied at a time interval to each of the experimental groups. In this design, subjects were subjected to continuous intervention, and the effects of each intervention were compared. The advantage of this experimental design is that it can compare the effects of the intervention within the subjects of one group rather than comparing the results between different groups and can reduce the measurement variance. In this study, pre- and post-intervention evaluations were conducted to determine the changes in the angle of the cervical vertebrae, the changes in the pain thresholds around the cervical vertebrae, and the ROM of the cervical vertebrae following the McKenzie's stretching exercise and dry cupping therapy. In order to minimize the learning effect of the subjects, the single blind method was applied which does not allow the subjects to be aware of the purpose of the study (Figure 1).

#### *McKenzie stretching*

1. Head retraction and neck extension was performed in a sitting position.
2. Head retraction and neck flexion was performed in a supine position.
3. The right hand was placed on the opposite side shoulder and head-turning was performed in a sitting position. This was repeated in the opposite direction.
4. Neck flexion was performed in a sitting position.



**Figure 1.** Flow diagram of total experimental procedure.

5. Left and right lateral bending was performed in a sitting position.

To assess the maximal muscle contraction of the subject, a 7-second contraction was performed 10 times for each operation. The above operation was applied for a total of 8 minutes. The time, posture and frequency of administration were supervised to ensure that all subjects were able to perform same as much as possible [11].

#### *Dry cupping*

The cupping technique was applied to each subject's levator scapular and upper trapezius one by one, respectively. A plastic cup of 25 to 50 mm size was selected according to the application area of the subject. After applying the plastic cup to the site, air was taken out by the compressor to create a vacuum state. The application time of the cupping was applied for 8 minutes.

#### **Measurements**

##### *Smartphone goniometer*

The smartphone was placed on a tripod and positioned horizontally. Setting the distance between the shoulder tip of the subject and the tripod was 1.0 meters, and the distance between the eye and the tripod of the subject was 0.3 meters [12].

A1: Investigator A measured the craniovertebral angle by palpating the spinous process of C7 and pointed it to the finger. Investigator B used the "On protractor" application to measure the angle between the transverse plane of the spi-

nous process of C7 and the tragus of ears around C7.

A2: To measure the head position angle, investigator A pointed to the jugular notch with the fingertip. Investigator B measured the angle between the jaw and the jugular notch around the tragus of ears.

##### *Algometer*

After assuming a sitting position on the chair, the subject measured the pressure pain threshold according to the pressure of the upper trapezius using an Algometer (J-tech Medical, Midvale, UT, USA). In order to measure the pressure pain threshold, the Algometer was applied at a rate of 1 kg/sec vertically to the test site. The moment when subject sent the signal voice of 'Ah', it was regarded as the beginning of pain sensation and was measured in units of kg/cm<sup>2</sup>. The same investigator measured three consecutive times and calculated the mean values. The most severe painful trigger point on the left and right upper trapezius were measured before and after each treatment.

##### *Cervical range of motion instrument*

Cervical ROM (CROM) was measured by the Cervical Range of Motion Instrument (CROM3, Performance Attainment Associates and MedNet Technologies, New York, USA) and was applied for cervical flexion, extension, left lateral flexion, and right lateral flexion. Active ROM of the subject was measured by placing the foot on a fixed chair and attaching it to the floor with both hands stretched out lightly towards the knees. Measurements were done once before and after. The ROM of the cervical spine was up to 80° to 90° in flexion, and extension was normally limited to 70° [13]. Left right cervical flexion were approximately 25° to 45°, occurring mostly between the occipital bone and the first cervical vertebrae, and between the first and second cervical vertebrae.

#### **Data analysis**

The data collected in this study were statistically processed using IBM SPSS Statistics ver. 20.0 (IBM Co., Armonk, NY, USA). To investigate the effect of each treatment method on the dependent variables, the paired t-test was used to calculate and compare the mean values of the measurements. Independent t-test was performed to verify the difference between before and after intervention. The statistical significance level was set at  $\alpha = 0.05$ .

## Results

### General characteristics of subjects

This study consisted of 18 subjects including 12 males and 6 females. The average age of subjects was 22.66 years, with a height of 166.58 cm and a body weight of 59.5 kg (Table 1).

### Within subject changes before and after the McKenzie stretching method

The angle of the cervical spine A1 increased by  $-0.75 \pm 5.82^\circ$  and the turtle neck angle A2 increased by  $-1.31 \pm 3.88^\circ$ . Both the angle A1 and A2 had no significant difference (Table 2).

The pain threshold was decreased by  $0.91 \pm 11.83$  in the right upper trapezius but there was no significant differences. The left upper trapezius was decreased by  $5.03 \pm 10.09$  and there was a significant difference ( $p < 0.05$ ; Table 2).

The ROM in cervical spine flexion increased by  $-6.94 \pm$

**Table 1.** General characteristics of the participants (N=18)

Characteristic	Value
Sex	18
Male	12
Female	6
Age (yr)	22.66 (2.98)
Height (cm)	166.58 (5.57)
Weight (kg)	59.5 (5.01)

Values are presented as number only or mean (SD).

$11.90^\circ$  and there was a significant difference ( $p < 0.05$ ). Cervical spine extension increased by  $-0.94 \pm 9.08^\circ$  but there was no significant difference. Right lateral flexion increased by  $-2.44 \pm 6.59^\circ$  but there was no significant difference. Left lateral flexion increased by  $-3.33 \pm 4.65^\circ$  and there was a significant difference ( $p < 0.05$ ; Table 3).

### Within subject changes before and after the cupping treatment

The angle of the cervical spine A1 decreased by  $-0.56 \pm 7.30^\circ$  but there was no significant difference. The turtle neck angle A2 increased by  $-1.14 \pm 5.19^\circ$  but there was no significant difference (Table 2).

Pain threshold was increased by  $-16.24 \pm 12.57$  in the right upper trapezius and there was a significant difference ( $p < 0.05$ ). The left upper trapezius was increased by  $-13.51 \pm 13.40$  and there was a significant difference ( $p < 0.05$ ; Table 2).

The ROM in cervical spine of flexion increased by  $-10.88 \pm 11.99^\circ$  and there was a significant difference ( $p < 0.05$ ). The extension increased by  $-10.00 \pm 8.67^\circ$  and there was a significant difference ( $p < 0.05$ ). The right lateral flexion increased by  $-8.61 \pm 7.19^\circ$  and there was a significant difference ( $p < 0.05$ ). The left lateral flexion increased by  $-7.50 \pm 7.01^\circ$  and there was a significant difference ( $p < 0.05$ ; Table 3).

### Comparison between the McKenzie stretching group and cupping group

In the comparison of the difference both pain threshold.

**Table 2.** Changes in the cervical angle, FHP angle and pain threshold at pre- and post-program (N=36)

Variable		McKenzie stretching group (n=18)	Cupping therapy group (n=18)	Difference (post-pre)		t (p)
				McKenzie stretching group	Cupping therapy group	
Cervical angle ( $^\circ$ )	Pre	48.94 (8.20)	52.39 (6.47)	-0.75 (5.82)	-0.56 (7.30)	0.596 (0.555)
	Post	49.69 (7.15)	51.83 (9.14)			
	t (p)	-0.551 (0.589)	0.323 (0.750)			
FHP ( $^\circ$ )	Pre	32.95 (4.35)	34.12 (5.20)	-1.31 (3.88)	-1.14 (5.19)	0.108 (0.914)
	Post	34.26 (4.84)	35.26 (3.40)			
	t (p)	-1.431 (0.170)	-0.930 (0.363)			
Right pain threshold	Pre	48.60 (16.59)	45.50 (13.33)	0.91 (11.83)	-16.24 (12.57)	-4.216 (0.000)
	Post	47.69 (14.59)	61.74 (17.85)			
	t (p)	-0.323 (0.747)	-5.487 (0.000)			
Left pain threshold	Pre	51.13 (18.17)	47.55 (13.20)	5.03 (10.09)	-13.51 (13.40)	-4.691 (0.000)
	Post	46.09 (16.13)	61.06 (14.60)			
	t (p)	2.118 (0.049)	-4.271 (0.001)			

Values are presented as mean (SD).  
FHP: forward head posture.

**Table 3.** Changes in the cervical range of motion at pre- and post-program (N=36)

Variable		Mckenzie stretching group (n=18)	Cupping therapy group (n=18)	Difference (post-pre)		t (p)
				Mckenzie stretching group	Cupping therapy group	
Flexion (°)	Pre	47.88 (10.40)	52.33 (7.95)	-6.94 (11.90)	-10.88 (11.99)	-0.990 (0.329)
	Post	54.83 (12.20)	63.22 (9.83)			
	t (p)	-2.472 (0.024)	-3.851 (0.001)			
Extension (°)	Pre	71.11 (9.60)	68.55 (13.11)	-0.94 (9.08)	-10.00 (8.67)	-3.050 (0.004)
	Post	72.05 (14.16)	78.55 (12.68)			
	t (p)	-0.443 (0.665)	-4.889 (0.000)			
Right lateral flexion (°)	Pre	40.05 (7.33)	43.16 (8.64)	-2.44 (6.59)	-8.61 (7.19)	-2.681 (0.011)
	Post	42.50 (6.11)	51.77 (8.35)			
	t (p)	-1.574 (0.134)	-5.071 (0.000)			
Left lateral flexion (°)	Pre	42.11 (6.25)	45.00 (6.60)	-3.33 (4.65)	-7.50 (7.01)	-2.103 (0.043)
	Post	45.44 (5.76)	52.50 (6.98)			
	t (p)	-3.041 (0.007)	-4.533 (0.000)			

Values are presented as mean (SD).

We found significant difference between the groups ( $p < 0.05$ ; Table 2). In the comparison of the difference cervical extension, both lateral flexion. We found significant difference between the groups ( $p < 0.05$ ; Table 3).

## Discussion

Among the various causes of cervical spinal pain, mechanical dysfunction is the most common cause, and dysfunction of the intervertebral joints reduces the mobility of the cervical spine segments. If the clinical diagnosis is judged to be a functional dysfunction of the intervertebral joint, joint mobilizations or chiropractic are selected for the treatment. McKenzie's [14] cervical exercise is expected to be effective in correcting posture of the neck, and exercise can indirectly reduce stress and chronic myalgia previously experienced by the patient. Many of the therapists have developed cupping therapy for the treatment of musculoskeletal disorders through diverse studies that expected to be a new trend in the field of sports medicine when applied in conjunction with movement patterns or functional exercises [10].

Clare *et al.* [11] suggested that the angle of the cervical vertebrae was significantly smaller in the group with pain, and that the smaller the angle of the cervical vertebrae, the greater the forward head posture (FHP). Increased load on the cervical spine muscles and joints caused by FHP is a major cause of work-related musculoskeletal pain and disease [15]. FHP is associated with pain, fatigue, and limited move-

ment of the cervical vertebrae in relation to muscle imbalance [16]. To cope with these problems, Sling exercises [17], McKenzie exercises [11], and the hold-relax method of proprioceptive neuromuscular stimulation [18] have been used and are effective on cervical spine angles, in maximizing muscle strength of deep neck flexors, and controlling the level of pain. In this study, the effects of the McKenzie stretching and cupping treatments were assessed after a single intervention, which resulted in minimal effects on the structural changes of the skeleton. It is anticipated in the future studies that a long-term repeated treatment would be more effective.

Although pain does not cause neurotrophic muscle weakness, such as cervical neuromuscular lesions, it limits not only the ROM of the joints, but also causes many obstacles to daily activities [19]. In this study, after the McKenzie stretches, pain thresholds decreased with no significant difference in the upper right trapezius and a significant decrease in the upper left trapezius. This was due to poor blood supply and muscle ischemia. Hypoxia or vigorous or unfamiliar exercises may cause an accumulation of by-products, such as lactic acid and potassium, in the muscles and may result in temporary increased muscle tone [20]. Currently, the physiologic mechanisms of pain relief using the cupping method is not well known, but there are several theories. Firstly, as in acupressure or acupuncture, it releases a chemical transmitter that can block pain, such as serotonin, endorphin, and cortisol, which ultimately acts as an element that can alleviate the pain [21]. Secondly, nociceptor activa-

tion causes pain [22], presumably because the cupping treatment reduces pain by the antinociceptive and counter-irritation effect [23]. Thirdly, all non-invasive and non-pharmacological treatments have placebo effects. In a recent randomized trial, it was reported that a sham device was more effective in relieving pain than the placebo [24]. In previous studies, the pain threshold of the dry-bulging group increased in a randomized trial of 15 painful chronic neck pain patients compared to the pain thresholds of the dry-cupping group and the control group [3]. Neurophysiological mechanism increased the pain threshold by the application of cupping treatment, and the same result was confirmed in this study.

Decreased joint mobility in the neck affects the adjacent joints as a compensatory action to produce the pathological movement chain of the entire vertebra [25]. Therefore, the two functions of mobility and stability must be mutually intertwined to functionally carry out daily life and desired tasks. Tension headaches also have been reported to be inversely correlated with the ROM of the cervical vertebrae [26]. In this study, although the ROM of the cervical vertebrae tended to increase in all directions in the McKenzie stretching group, cervical flexion and left lateral flexion increased significantly but extension and right lateral flexion were not significantly different. Personal differences in strength and characteristics may have accounted for this. The ROM of the cervical vertebrae in the cupping group increased significantly with flexion, extension, and right and left lateral flexion, which may be attributed to the mechanical effects of the cupping. Cupping has the capacity of effective manipulation of body structures such as tissues, fascia, skin, and muscle tissue, which increases the neurophysiological activity levels. As a result, cupping can eventually be explained by a study that can lead to strong relaxation [27]. Cupping treatment is more effective in improving the ROM of the cervical spine and pain thresholds compared to the McKenzie stretching method. In the future, cupping treatment may be considered as one of the treatment options for managing pain and ROM limitations of the cervical spine.

### Conflict of Interest

The authors declared no potential conflicts of interest with respect to the authorship and/or publication of this article.

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