Narrative Review: Effects of Manipulation and Mobilization Techniques of Cervical Spine on Pressure Pain Threshold in Neck and Shoulder Muscles

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Neck pain is one of the most common problems seen in medical practice. There are various factors that can cause or provoke neck pain. Myofascial trigger points in shoulder and neck regions are among the most effective factors that may provoke neck and head pain. Recently, it has been revealed that there is a clinical relationship between myofascial trigger points and joints dysfunction. Accordingly, different studies have been conducted in order to evaluate therapeutic effects of different manual approaches including mobilization and manipulation on improving Pressure Pain Threshold (PPT) as an indicator of changes in sensitivity of muscles. The aim of the present study was to conduct a narrative review to evaluate effects of manipulation and mobilization techniques of cervical spine on PPT in neck and shoulder muscles. From among different studies which have assessed the effectiveness of manual techniques directed on cervical spine, 10 most related studies were selected and the therapeutic approaches and results of these studies were studied. Review of these studies indicated that the application of manual techniques on cervical spine, such as manipulation and mobilization, could increase range of motion in cervical spine and even mouth opening according to relationship between cervical spine and tempromandibular joints. On the other hand, according to the relationship between joints and muscles, applying these techniques on cervical spines could improve PPT.

Keywords: Manipulation, Mobilization, Pressure Pain Threshold, Cervical Spine

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Introduction

Neck pain is a common problem in the general population, which can provoke headache, tempromandibular pain, a limited range of motion in neck, and feeling of stiffness (1). The prognosis for chronic neck pain is poor. Chronic neck pain causes major financial loss due to the costs of diagnosis and treatment (2).

A number of factors can cause or provoke neck pain. Myofascial trigger points in shoulder and neck regions are among the most effective factors that may provoke neck and head pain. The relationship between neck pain and myofascial trigger points (MTrPs) was previous revealed in the literature (3-7). Myofascial trigger points are defined as hypersensitive tender spots associated with a taut band of a skeletal muscle that is painful on compression or stretch and gives rise to a referred pain pattern distant from that spot, and if they are sensitive enough, they can cause referred pain and autonomic disorders (8).

Several therapeutic approaches have been proposed for the treatment of MTrPs. Physical therapy techniques can be divided into three groups: 1. Manual therapies (including pressure release, muscle energy technique, strain counter strain, Spray and stretch, Massage, etc., 2. Needling therapies (dry needling and wet needling), and 3. Other techniques (laser therapy, thermotherapy, etc.) (9).

It has been suggested that there is a clinical relationship between myofascial trigger points and joints dysfunction (8, 10). In the recent studies, it is revealed that the presence of MTrPs in the upper Trapezius muscle is associated with the cervical C3-C4 vertebrae dysfunctions, including hypomobility, abnormal end feel, increased stiffness, and a decreased joint mobility (11). On the other hand, it has been revealed that in peoples who suffer from migraine, the prevalence and the number of active MTrPs is high. Also, referred pain originating from different myofascial trigger points in the head, neck, or shoulder muscles could potentially cause or provoke symptoms in migraine sufferers. Moreover, it is suggested that common etiological factors in migraine and MTrPs, such as emotional or physical tension which can cause MTrPs in neck and shoulder muscles, also affect manifestation of migraine (12). Fernández-de-las-Peñas *et al.* demonstrated further prevalence of active MTrPs in upper Trapezius, sternocleidomastoid, and temporalis muscles in cronic Tension-Type Headache (CTTH) patients. Also, they suggested that severity of headache (intensity and duration) could be affected by existence of active MTrPs. In

another study, it was shown that Episodic Tension-Type Headache could decrease total cervical range of motion and increase prevalence of active MTrPs in the upper Trapezius, sternocleidomastoid, and temporalis muscle (3, 5).

According to the principle that there is a reverse relationship between trigger points of upper Trapezius muscle and range of motion in the cervical vertebrae (13), in the recent studies, therapists use a treatment approach that includes different techniques which focus on both muscle and joint impairments. It may be hypothesized that the treatment of an intervertebral joint dysfunction could have a therapeutic effect on MTrPs located in those muscles innervated by the same segment (14).

Various therapeutic approaches had been applied to treat joint dysfunction, like passive manipulation and mobilization, active mobilization, and neuromuscular facilitation. Previous evidences suggested that these techniques have hypoalgesic effects which activate a nonopioid descending inhibitory pathways and Sympathetic Nervous System (SNS). The degree of activation depends on the severity and duration of techniques (15-17).

Manipulation and mobilization are the most widely used techniques in the treatment of dysfunctions related to the joints and spine. Manipulation is defined as a high velocity and low amplitude localized force applied on the joint. Mobilization is defined as a low velocity, small or large amplitude, and passive movements. Application of spinal manipulation on the upper cervical spine might be concomitant with adverse effects like arterial dissection (18), so it seems that application of mobilization techniques instead of manipulation in the upper cervical spine treatments is more sensible.

According to the relationship of trigger points in shoulder, cervical, and masticatory muscles and cervical dysfunctions, in the recent studies, therapeutic effects of spinal manipulation and mobilization in the changes of range of motion in cervical spine or mouth opening and changes in PPT, as an indicator to measurements of changes in soft tissue, were examined.

Review of the related article

For the first time, Vernon *et al.* in a case study evaluated the effect of spinal manipulation on PPT in a 22 year-old male with a five year history of right side neck, scapular and arm pain. This study demonstrated an increase in PPT after spinal manipulation (6). Also, Vernon *et al.* designed a pilot study with nine participants suffering from chronic mechanical neck pain syndrome. They aimed to evaluate the effects of PPT over tender points in the paraspinal area after a spinal manipulation. The participants were allocated randomly in two groups: oscillatory mobilization of the cervical spine, as the control group, and a manipulation of the cervical spine, as intervention group. The results of this study confirmed previous case studies on immediate effects of manipulation technique on the improvement of PPT in patients with neck pain (7).

Several years later in 2007, Ruiz-Sáez *et al.* analyzed changes on PPT levels in latent MTrPs in the upper Trapezius muscle after a cervical thrust manipulation. A total of 72 pain-free volunteers diagnosed with latent MTrPs in the upper Trapezius muscle and clinical presentation of intervertebral joint dysfunction were included in the study. Participants were randomly divided into two groups: manipulative group, that received the high-velocity, low-amplitude thrust on C3- C4, and a placebo group. Manipulation was performed as follows: The index finger of the therapist was placed over the posterior lateral aspect of the spinous process at the dysfunctional side of the C3 vertebra. Gentle ipsilateral side flexion and contra lateral rotation were applied from the restricted side until slight tension was palpated. A high-velocity, low-amplitude manipulation was applied medially in the direction of the participant's contra lateral eye. The manipulation procedure was applied to either right or left side based on the location of MTrPs and the joint dysfunction. The control group received a sham manual procedure. Three consecutive measurements of PPT levels were obtained on the upper Trapezius MTrP at intervals of 30 seconds and the mean was considered in the analysis. They concluded that manipulation technique could increase PPT in the experimental group (11). This study was the first clinical trial that examined the effectiveness of manipulation as a hard tissue technique on PPT of Trapezius as a soft tissue.

César Fernández-de-las-Peñas *et al.* (14) applied Cervicothoracic Junction (C7-T1) manipulation to assess changes of PPT over bilateral C5-C6 zygapophyseal joints in 30 asymptomatic participants. In this study healthy participants were randomly assigned into 3 groups: trust manipulation directed at the right side of the C7-T1 joint, trust manipulation directed on the left side of the C7-T1 joint, and a placebo group. The results of this study suggested that a manipulation could change the PPT in both right and left C5-C6 zygapophyseal joints in healthy participants.

According to the interrelationship between cervical spine and tempromandibular joint as well as the functional relationship between the mandibular and the head-neck systems, as suggested by their anatomical and biomechanical inter-relationships, La Touché *et al.* (19) in 2009 conducted a study in order to evaluate the effects of mobilization of cervical spine on pain and pressure pain sensitivity in patients with myofascial tempromandibular disorders. A total of 19 participants with presence of at least one trigger point in the masseter or temporalis muscles were included in the study. Treatment protocol included: 1) upper cervical flexion mobilization with rate of one oscillation per 2 s for a total time of 10 min, 2) C5 central posterior-anterior mobilization on spinous process, and 3) Cranio-cervical flexor stabilization exercise. All patients received a total of 10 treatment sessions over a five- week period (twice per week). The results of the study demonstrated that combination of manual therapy and exercise caused an immediate decrease (48 h after 10 treatment sessions) in facial pain, an increase in PPTs over the masticatory muscles, and an increase in mouth opening. Also, follow-ups showed that the effects of treatment were maintained 12 weeks later. However this study had poor methodological quality as

no control group was considered in the study and the sample size was small, but it was one of the first studies that evaluated the effect of mobilization of soft tissue sensitivity and range of motion of a farther joint.

Mansilla-Ferragut *et al.* evaluated the effectiveness of a spinal thrust manipulation of atlanto-occipital on active mouth opening and pressure pain sensitivity in a trigeminal nerve innervated region located on sphenoid bone in women with mechanical neck pain. Thirty-seven participants were randomly allocated into one of the following groups: a spinal manipulation of the atlanto-occipital joint group or a control group that received sham treatment. This study conformed the immediate effects of manipulation technique on improvement of mouth opening and PPts over both sides of the sphenoid bone (trigeminal nerve innervations region) (20).

De Camargo *et al.* evaluated electromyography (EMG) changes of the deltoid muscle and PPTs in patients with mechanical neck pain after manipulation of C5-C6 spinal vertebrae. Thirty-seven participants were randomly assigned into two groups: a cervical spine manipulation group and control group. The conclusion of this study conformed the effectiveness of manipulation at C5-C6 level in the increase of EMG amplitude signal in rest status, isometric contraction for 5 or 30 seconds, and isotonic contraction and fatigue resistance in a deltoid muscle innervated by the same segment. Also, an increase was observed on PPT over the upper Trapezius and deltoid muscles and C5 spinous process (21).

La Touché *et al.* in 2013 carried out another study on participants with cervico-craniofacial pain to evaluate changes in autonomic nervous system function and PPT after cervical spine mobilization. The mobilization was applied at a rate of 1 oscillation per 2 seconds (0.5Hz). The total time of mobilization was 6 minutes, which was carried out three sessions a week for two weeks. Several characteristics were measured to assess the SNS including: skin conductance, heart rate, breathing rate, and skin temperature. The results of this study indicated that PPTs in the masseter muscle, temporalis, suboccipital, upper Trapezius muscle, and C5 zygapophyseal joint showed significant increase. Also, this technique significantly increased SNS activity and produced short-term hypoalgesic effects. The authors concluded that mobilization causes sympathoexcitation, on the other hand, the present study confirmed the influence of the mobilization on the CNS (medullar or supramedullar effect) (22).

Considering the relationship between active MTrPs and mechanical neck pain, chronic tension type headache, and migraine, Oliveira-Campelo *et al.* in 2010 (23) evaluated the effectiveness of atlanto-occipital joint manipulation, as a manual technique of the cervical spine, on active mouth opening and pressure pain sensitivity over latent myofascial trigger points in the masticatory muscles.

A total of 122 participants with latent MTrPs in the masseter muscle were randomly assigned into three groups: Atlanto-occipital joint thrust manipulation, Suboccipital muscle inhibition technique, and control group. PPT levels over latent MTrPs within the masseter or temporalis muscles and active mouth opening were assessed two minutes after interventions. This study indicated that cervical manipulation and soft tissue inhibition technique can cause mechanical hypoalgesic effects over latent myofascial trigger point located in the trigeminal region (masseter and temporalis muscles) and increase PPT. However, the effect size of the study was small and the results of the study were not statistically significant.

Moreover, Fernandez-de-las Peñas *et al.* evaluated the effects of mobilization of T4 to T1 thoracic vertebrae, C7-T1 Cervicothoracic junction, and C1-C2 vertebrae along with manual techniques of myofascial trigger point treatment in tension-type headache patients. They claimed that common manual techniques used to treat MTrPs are not adequate for treating tension type headaches. Thus, they combined the manual techniques (soft tissue stroke, pressure release, or muscle energy) with mobilization to obviate the defect. In this study, mobilization techniques were performed as following: a 30-second grade III or IV central posterior-anterior none thrust mobilization or manipulations with an overall intervention time of 5 minutes. Manual techniques were applied to temporalis, suboccipital, upper Trapezius, splenius capitis, sternocleidomastoid, and semispinalis capitis muscle in order to deactivate MTrPs. Significant improvements in neck mobility, PPT, total tenderness score, and presence of muscle MTrPs as well as high indices on the 36-Item Short-Form Medical Outcomes Study, the Neck Disability Index (NDI), the Beck Depression Inventory, and the Headache Disability Inventory show effectiveness of mobilization technique combined with the manual trigger point therapy in improvement of tension headaches (24).

Carr *et al.* (25) studied the effects of manipulation of Cervicothoracic spine in healthy participants. They assessed changes of PPT over the midpoint between C7 and the acromion along the upper Trapezius muscle belly 5 and 10 minutes after intervention and also cervical range of motion immediately after the intervention.

A total of 95 healthy participants were recruited in this study and were randomly assigned into three groups: Upper Trapezius stretch, Cervicothoracic manipulation, and control group. The conclusion of this study was approximately different. No significant differences were found in CROM or PPT when pre-treatment to post-treatment values were compared. The results showed that there was no significant differences between Cervicothoracic manipulation and upper Trapezius stretching, compared with those of the control group. This may have occurred for a number of different reasons. A majority of participants who participated in the study were athletes and were engaged in different sports training. Also, they were all healthy without any neck pain,

while the wide age range (18-70 years old) of the participants could influence the results of the study. Moreover, another reason which could affect the results was lack of test-retest reliability that could have led to inter-rater error.

Discussion

There are several theories on interrelationship between trigger points of muscle and joints dysfunctions. The theory that trigger points could create or excite the joint dysfunction was proposed by Dommerholt *et al*. They suggested that an abnormal sensory input from the joint dysfunction could provoke the trigger point activity. On the other hand, it has been suggested that the increased tension of the taut bands and facilitation of motor activity can cause displacement stress on the joint and maintenance of this stress can cause joint dysfunction (26).

Review of the articles revealed that application of manipulation and mobilization techniques could increase the PPT in symptomatic or non-symptomatic individuals. Possible explanations for the increased PPT levels include: reduction of chemical algogenic mediators or activation of segmental inhibitory pathways and activation of central descending inhibitory pathway. Furthermore, they may induce a reflex inhibition of pain or a reflex muscle relaxation by stimulation of joint mechanoreceptors.

It has been suggested that manipulation and mobilization techniques may cause analgesic effects throughout the activation of the endogenous opiate system, the alteration of chemical mediators, or possible activation of segmental inhibitory pathways. On the other hand, these techniques would reflex muscle relaxation by modifying proprioceptive group 1 and 2 afferents (27, 28).

The upper Trapezius muscle receives nerve innervations from the C2-C4 levels; therefore, it may be possible that the therapeutic procedures such as manipulation and mobilization exerted on these segments could change the upper Trapezius MTrP sensitivity, including PPT or pressure pain tolerance (11).

Conclusion

The application of manual techniques on cervical spine such as manipulation and mobilization could increase range of motion in cervical spine and even mouth opening according to relationship between cervical spine and craniofacial and tempromandibular joints. On the other hand, according to the relationship between joints and muscles, applying techniques on cervical spines could improve muscle sensitivity in neck and shoulder. PPT, as a factor that shows changes in sensitivity of muscles, indicated improvement after spinal manual techniques. However, more studies with higher standards are required to make decisive conclusions.

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