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The association of medial scapular muscle pain on distance of mouth opening in participants with scapulocostal syndrome: an exploratory study

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KEYWORDS
Myogenic-TMD;
Upper quarter pain syndrome;
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ABSTRACT
Evidence-based studies have reported an association between myogenous-temporomandibular disorder and medial scapular muscle pain. However, the influence of medial scapular muscle pain on distance of mouth opening has still not been investigated. This study aimed to investigate the effect of medial scapular muscle pain on distance of mouth opening in participants with scapulocostal syndrome (SCS). One-hundred and one convenient participants with SCS totaling more than 3 months (14 males and 87 females) were recruited. Participants were divided into three groups consisting of mild, moderate, and severe pain (aged 26.33 ± 1.16, 27.85 ± 0.76, and 27.44 ± 1.10, respectively). The distance of mouth opening was measured in two conditions; pain-free mouth opening and maximum mouth opening. The distance of mouth opening among three groups were compared using Kruskal-Wallis test with Dunn-Bonferroni post hoc analysis. Kruskal Wallis test reported that the distance of maximum mouth opening was significantly different among three groups (p-value < 0.035). Dunn-Bonferroni post hoc found a statistically significant difference in distance of maximum mouth opening between moderate and severe pain groups (p-value = 0.042). In conclusion, medial scapular muscle pain tends to influence maximum mouth opening. Therefore, therapists should assess the distance of maximum mouth opening amid treatment of patients with SCS.

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Introduction

Measurement of distance of mouth opening is a common method used to describe movement pattern and muscle performance in patients with myogenous-temporomandibular disorder (myogenous-TMD) or masticatory myofascial pain (MMP)[1]. Although, most previous studies exhibited association between neck discomfort and increase of severity of symptoms in participants with MMP, none of these studies mentioned the interaction between medial scapular muscle pain and jaw function[2-6].

Various studies found the influence of neck pain on MMP. Kraus (2007), Pasinato et al. (2016), and Padamsee et al. (1994) established that neck pain can increase pain severity in the stomatognathic system[3,6,7]. Zafar et al. (2000) reported that active movement of mouth opening and mouth closing correlated with neck function[8]. Moreover, Hellmann et al. (2012) and Giannakopoulos et al. (2013) reported decreased bite force in MMP patients with neck pain. Previous studies also strongly recommended therapists assess the neck and its structures amid clinical assessment of MMP patients[3,9-11].

The highest prevalence of trigger point (18-30%) was shown in levator scapulae followed by upper trapezius (13-19%)[12]. These muscles provided stability and prevented forward neck flexion, and rotation during static work position, such as using the computer. Likewise, Larsson et al.[13] mentioned that prolonged muscle fiber activation of the levator scapulae and neck extensors during long hours of computer work may lead to development of pain and tenderness. In addition, neck extensor, such as the upper trapezius is innervated by the accessory nerve which attaches to the trigeminal nerve at the trigeminocervical nucleus[14]. Therefore, any injury on the neck muscles may affect the masticatory muscle pain through this connection.

Notably, there are various neck muscles attached to the scapular area. It is well-established that scapular muscles are the main stabilizer of the neck; consequently, some muscle fibers, nerves, and other structures can become concomitantly merged. Any injury to the axioscapular muscle can affect the neck muscles[15,16]. According to this connection, it is difficult for therapists to differentiate the source of pain in patients who report pain at the neck and scapular regions.

Scapulocostal syndrome or SCS concerns pain symptoms exhibited in the scapular area related to abnormal postures in individuals with neck disorders[12,17,18]. Previous studies reported that treatment of the scapular area can improve neck function performance[12,14]. These results implied that the impairment of one part of the body can affect the adjacent areas which lie above or under said structure. Therefore, therapist should also be aware of and assess the adjacent areas of the pathological site. Nevertheless, the influence of medial scapular muscle pain on the distance of mouth opening has not been previously mentioned.

According to the above mentioned, it could be concluded that jaw and neck, and neck and scapula were connected in various aspects. The evidence emphasizes the linkage between the jaw and neck via the sensory-motor-system[19], while the neck and scapula were linked via the axioscapular muscles[15,16]. Moreover, the evidence has also revealed that functional disorders of the upper cervical spine (occiput to C3) are related with the lower cervical spine (C3 to C7) and TMJ[20]. Thus, cervical dysfunction can cause both craniomandibular disorders[6,10,21,22] and the scapular muscles pain. However, the effect of scapular muscles pain on the stomatognathic system is still lacking.

Therefore, this study aimed to investigate the effect of medial scapular muscle pain on distance of mouth opening in patients with SCS. We hypothesized that severity of pain in the medial scapular muscles may associate with the distance of mouth opening in two conditions, i.e. pain-free mouth opening (MO) and maximum mouth opening (MMO) due to masticatory muscle pain.

Materials and methods

Participants

One-hundred and one participants with SCS for more than 3 months were recruited. Patients' subjective information regarding history of medial

scapular muscle pain, pain duration, and working duration were collected. Inclusion criteria were male or female aged between 18 to 50 years who reported chronic pain symptom in the medial scapular muscles along with the medial scapular area at not less than 3 points with a specific referral pattern followed by the description of trigger point by Travell and Simon (1999)[23]. Participants were excluded if they reported a history of TMD with disc displacement, TMJ osteoarthritis, a history of serious systemic disease or serious condition such as fracture, trauma, surgery of the cervical spine, or inflammatory disease.

Participants were allocated into 3 groups based on severity of pain intensity during receiving pressure in the medial scapular muscles, based on a mild (VAS = 0-30 mm.), moderate (VAS = 40-60 mm.), and severe pain scale (VAS = 70-100 mm.). Participants were recruited via advertisement and those who met inclusion criteria were informed of the purposes and procedures. Consequently, they were asked to sign a consent form. The study was conducted at Research Room 5 in the Faculty of Associated Medical Science, Khon Kaen University, Thailand. This study was approved by the Khon Kaen University Ethics Committee for Human Research (HE 612318).

Measurements

This research used a visual analog scale (VAS) to assess pain intensity in the most painful areas of the medial scapular muscles consisting of the levator scapulae, rhomboid minor and major, serratus posterior superior, and upper trapezius muscles. The assessment position required subjects to be in the sitting position with shoulder adduction and internal rotation with the assessor placing their hand on the opposite shoulder to the affected side (Figure 1). The assessor applied compression force (2 kg/cm^2) along the medial scapular area which is the insertion point of the medial scapular muscles. Participants were measured for the tender spot along the medial scapular muscles for at least three points in order to represent pain of those five muscles mentioned above. During the assessment period, participants were asked to explain the pattern of muscle referred pain and asked to select the most painful area. The selected point was used to assess the pain intensity. The reliability and construct validity of VAS were reported to be high (r = 0.99 and gamma = 0.77 to 0.89, respectively)[24,25]. Whereas, the reliability of the palpation in the diagnosis of myofascial pain syndrome and myofascial trigger point was reported to be good (K = 0.81), and the validity showed high values of sensitivity and specificity (sensitivity = 0.92, specificity = 1.00)[26].

Figure 1 Assessment position for pain intensity in the medial scapular muscles

The TheraBite™ was used to measure the distance of mouth opening for both conditions. For the pain-free mouth opening (MO) condition, participants were asked to open their mouth without pain or discomfort in masticatory muscles. Whereas, for the maximum mouth opening (MMO) condition, participants were asked to open their mouths as wide as possible even if they felt pain in the masticatory muscles. The distance of mouth opening was measured by the distance between the incisal edges of the upper and lower central incisors. This method was reported to present excellent reliability amid both measurements by a therapist (r = 0.90 to 0.96)[27] and by patient self-measurement (r = 0.92)[28].

Painful areas were marked on a clear-plastic sheet by the researcher to guide the testing area for the assessor in order to perform pain intensity testing. Outcome measurements were assessed amid 3 repetitions. Participants were asked to rest for 1 to 2 minutes between each test.

Statistical analysis

Descriptive statistics were performed on demographic data and presented as means, standard deviations (SDs) and medians. Kolmogorov-Smirnov showed non-normal distribution of pain intensity in the medial scapular muscles and mouth opening distance for both conditions; therefore, the non-parametric (Kruskal–Wallis) test was conducted to determine the differences in distance of mouth opening conditions among groups. Dunn-Bonferroni test was used for pairwise comparison. The author employed SPSS version 23.0 for Windows for data collection and data analysis. Significance level was set at *p*-value < 0.05.

Results

Demographic data, health status, and baseline characteristics

One hundred and one convenient participants with SCS for greater than 3 months (14 males, 87 females) were recruited and screened by the researcher from July 2019 to September 2020. Subjects were divided into three groups consisting of mild, moderate, and severe pain of the medial scapular muscles. Eighteen had mild pain, 58 had moderate pain, and 25 had severe pain (mean age (SD): 27.44 ± 1.10 years). Baseline characteristic data of the three groups are summarized in Table 1. There were no significant differences in baseline characteristic data among three groups. The results demonstrated that levator scapulae muscle was the most painful spot (77.2%) followed by rhomboids, and serratus posterior superior, respectively (Table 2).

Table 1 Baseline characteristics of the three groups: mean (SD)

Characteristic	Mild pain (n=18)	Moderate pain (n=58)	Severe pain (n=25)	*p*-value
Age (years)	26.33 ± 1.16	27.85 ± 0.76	27.44 ± 1.10	0.520
Weight (kg)	59.56 ± 3.28	58.10 ± 1.64	58.76 ± 2.43	0.846
Height (cm)	163.94 ± 1.66	161.19 ± 0.80	161.24 ± 1.69	0.080
BMI (kg/m^2)	22.07 ± 1.01	22.31 ± 0.58	22.53 ± 0.79	0.982
Working age (months)	35.89 ± 13.87	37.40 ± 7.66	37.12 ± 8.53	0.725
Working duration (hours)	5.28 ± 0.99	6.28 ± 0.50	6.40 ± 0.98	1.381
Weekly day (days)	3.78 ± 0.69	4.29 ± 0.32	4.24 ± 0.56	0.198
Pain duration (months)	18.83 ± 5.04	31.47 ± 4.49	26.48 ± 5.79	0.091
Pain of SCS	2.97 ± 0.17	5.28 ± 0.12	8.06 ± 0.13	0.038*

Note: Homogeneity test of variance, *p-value < 0.05

Table 2 Frequency of medial scapular muscle pain in all participants

Medial scapular muscle	N = 101	Percent (%)
Levator scapulae	78	77.2
Rhomboids	20	19.8
Serratus posterior superior	3	3
Upper trapezius	0	0

Distance of mouth opening

Median scores of distance of mouth opening are shown in Table 3. Kruskal-Wallis test reported that there was a statistically significant difference in distance of maximum mouth opening in terms of pain severity variations in the medial scapular muscle (p-value < 0.035) (see Figure 2). Dunn-Bonferroni test showed statistically significant differences between the moderate and severe pain groups. Distance of maximum mouth opening was significantly lower in SCS patients with severe pain (median of VAS score = 37.86) than those with moderate pain in the medial scapular muscles (median of VAS score= 55.09, p-value = 0.042) while the other groups' comparison did not showed any different significance (severe pain vs mild pain, p-value = 0.132, moderate pain vs mild pain, p-value = 1.000).

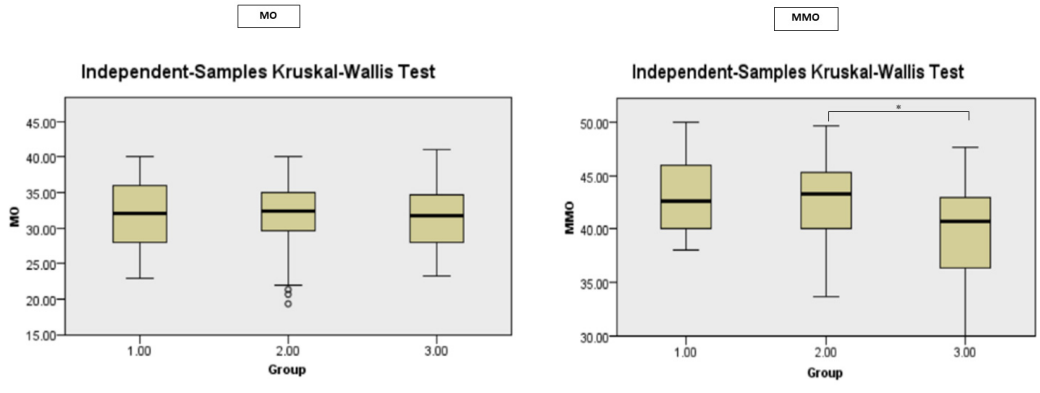

Figure 2 Comparisons of distance of mouth opening in terms of differences in pain severity variations among participants with SCS were presented as median score (mm)

Table 3 Distribution and median scores for distance of mouth opening (both MO and MMO) regarding severity of pain in the medial scapular muscles

Group/mouth distance	MO Mean rank (mm)	MMO Mean rank (mm)
Mild pain (n = 18)	53.06	56.08
Moderate pain (n = 58)	51.93	55.09
Severe pain (n = 25)	47.36	37.86

Discussion

To our knowledge, this is the first study to examine the effect of severity of pain intensity in the medial scapular muscles on the distance of mouth opening. The authors hypothesized that the distance of pain-free mouth opening and the distance of maximum mouth opening conditions were different among groups. The results of this study support the hypothesis that distance of mouth opening is affected by pain severity in the medial scapular muscles.

Even though the upper trapezius muscle lies covering the other medial scapular muscles, somatic referred pain pattern can be present at the medial scapular site. The most painful area experienced by SCS participants is presented in the levator scapulae muscle. However, the influence of pain in the medial scapular muscles was significantly presented in the maximum mouth opening condition only. The authors suggest that in pain-free mouth opening, only the masticatory muscles themselves suffice to maintain their function and neutrality. Whereas, in the maximum mouth opening condition, the demand from other muscles which lie in adjacent areas are needed.

The mechanics of mouth opening consists of three mandible motions, including depression, protrusion, and lateral excursion(29). Mandibular depression occurs with combination of rotation (approximately 25 mm) and anterior translation (approximately 15 mm) in the pain-free mouth opening (40 mm). Protrusion occurs with translation and minimal rotation of the mandibular condyle, whereas lateral excursion occurs with ipsilateral rotation and contralateral translation of the mandibular condyles[29]. In 2018, Wang et al. reported the effect of sustained maximum mouth opening in a novel mouse model of TMD[30]. The results demonstrated that sustained maximum mouth opening is risk factor of chronic TMD and inflammation associated with macrophage and microglia in the tissue (such as masseter muscle) and trigeminal system.

Furthermore, there is supportive information confirming the functional linkage between the human stomatognathic system and craniocervical region. In more detail, functions of the masticatory and neck muscles are automatically synchronized via neutral command of the motor systems during opening and closing of the mouth[8]. Moreover, a previous study mentioned that the mandible and neck concomitantly work amid the maximum mouth opening condition[8]. Notably, the neck muscles attached to the scapular region may affect jaw function as well.

In this study, the levator scapulae was the main structure to be focused because it was the most frequently reported painful in the results. A previous study reported that tenderness of the levator scapulae and upper trapezius were major sources of neck pain (18-30% and 13-19%, respectively)[12]. According to the myofascial linkage concept, muscles and fascia in the human body are connected in series, consequently, each muscle can influence more than one joint[31]. As a result, pain intensity amid these muscles may transfer to the neck and disturb jaw function, especially, maximum mouth opening. In this study, the results revealed that distance of maximum mouth opening was significantly lower in SCS patients with severe pain than those with moderate pain in the medial scapular muscles.

This study also discovered a significant impact of medial scapular muscle pain on distance of mouth opening. Although this study revealed impact of pain intensity on distance of mouth opening, reports of the positive impacts rendered by treatment in a clinical setting are still lacking. Henceforth, the authors suggest that the development of a treatment program which simultaneously focuses on SCS and jaw function would be worthwhile.

Unfortunately, there were some study limitations. Since, the nature of MMP is that of a fluctuating disorder, the findings may have been affected by activities of daily living, the time of assessment, and pain intensity in the masticatory muscles during the study period. Moreover, this study did not assess other jaw functions, such as bite force, yawning, and so on. Notably, future studies focusing on the association between SCS and other functions of the mandibular system are needed.

Conclusion

In conclusion, medial scapular muscle pain tends to influence distance of mouth opening, especially with regards to the maximum mouth opening condition. Notwithstanding, the masticatory muscles can maintain mandible neutrality during chewing or mastication. Pain and distance of maximum mouth opening tend to be affected by medial scapular muscle pain. Therefore, therapists ought to assess the distance of maximum mouth opening in the treatment of patients with SCS.

Take home messages

Individuals presenting chronic neck or scapular pain may experience a limited distance of mouth opening.

Conflicts of interest

The authors declare no conflict of interest.

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