Research Paper

Mildly Kyphotic Students Had More Shoulder Trigger Points Than Students With Normal Spinal Posture

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ABSTRACT

Objectives: Painful trigger points (PTP) may be caused or exacerbated by many factors, including abnormal spinal posture. This study compares PTP in the shoulder and scapular areas of mildly kyphotic subjects versus subjects with a normal spine among physiotherapy (PT) students enrolled at Shiraz University of Medical Sciences, Shiraz City, Iran.

Methods: A total of 60 PT students, 30 with mild kyphosis and 30 with a normal spine, were randomly and voluntarily recruited. The data collection was planned based on the subjects' spinal posture, shoulder and scapular pain levels, and the intensity of pain evoked in response to pressure. The spinal posture was assessed using a flexible ruler, while the trigger points were evaluated as described previously by Travell and Simon. A digital pressure algometer assessed the subjects' pain thresholds, and the pain levels were quantified using a visual analog scale (VAS).

Results: The data indicated significant differences between the mildly kyphotic subjects and individuals with a normal thoracic spine posture concerning their trigger points, pain scales, and pressure thresholds that caused pain. Despite the significant differences between both groups for their latent trigger points, the mean scores for the active trigger points were not significantly different.

Discussion: There were more trigger points in students with mild kyphosis than in subjects with a normal spine posture. Meanwhile, mild thoracic kyphosis, likely from imbalanced paraspinal muscles, may be linked to the development and or severity of trigger point pain in mildly kyphotic students.

Keywords:
Mild kyphosis, Painful trigger points (PTP), Posture, Pressure pain thresholds, Shoulder and scapular pain

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Highlights

- Mild thoracic kyphosis is a common disorder, causing painful trigger points (PTP) in the shoulder and scapular regions.

- Upon the analysis of data, representing the subjects' demographics, thoracic posture, and shoulder and scapular pain intensity, this study found significantly more trigger points in the mildly kyphotic students than in subjects with a normal thoracic posture.

- Mild thoracic kyphosis may result in trigger points around the shoulder and scapular areas, likely due to paraspinal muscle imbalances.

Plain Language Summary

Ignoring bad posture in young adults, especially university students, can result in mild kyphosis and subsequently painful spots around the upper back and shoulders. This condition is often caused by weakness in the paraspinal muscles. This common problem in young people can be avoided by training and encouraging them to do daily exercises. Such a healthy habit helps students maintain normal posture thus preventing the development of painful spots in the upper back and shoulders.

Introduction

Normal posture is a state of skeletal balance with minimal muscle tension or excessive stretch to soft tissues. Thus, to enjoy a correct posture, muscles, ligaments, joints, and other skeletal components should be in acceptable balance and harmony. Therefore, in the absence of normal skeletal posture and alignment, an impaired range of motion in our joints and muscles is developed [1, 2]. Thoracic kyphosis is one of the most common postural disorders in humans. It is described as increased thoracic spine curvature in the sagittal plane. It is the basis for the development of trigger points, muscular pain, the lungs' reduced vital capacity and fatigue, among others. On average, the sagittal plane's normal range of thoracic curvature is 20 to 40 degrees. If the curvature exceeds 40 degrees, it is considered kyphosis [3, 4], which may be mild, moderate, or severe. Depending on the mechanism of its development, kyphosis may be postural or structural, mainly affecting the trunk, shoulder, head and neck muscles.

Kyphosis may progress to painful trigger points (PTP) and cause referred pain to the individual's shoulders and other body parts [4, 5]. One of the leading causes of PTP is poor body posture. Recent research has suggested that the frequency of PTP in people with shoulder issues is higher in certain muscle groups [5, 6]. They often complain of PTP in their infraspinatus and upper trapezius muscles. Further, they may develop latent PTP in the teres major and anterior deltoid muscles [6]. Another study has reported that visual factors may significantly contribute to PTP in people who frequently work on computers [7]. High visual and postural stress may cause PTP in the left and right trapezius muscles [7]. Most body posture muscles are affected, including the shoulder, neck, and pelvic girdle muscles. A patient with trigger points often reports persistent and regionally spread pain that causes a reduced range of motion in the affected joints [7, 8].

PTPs are hypersensitive spots associated with palpable nodules found in taut bands of skeletal muscles. They are painful when stretched or pressed and are reliably detectable upon palpation [9]. About 30% to 85% of people referred to physiotherapy (PT) clinics present with PTP, more commonly in women. Meanwhile, 94% of patients with chronic pain suffer from trigger points [10, 11]. PTP may be latent or active. Active PTP is associated with spontaneous pain, but latent PTP is clinically silent and becomes painful only when palpated or needled [12]. Reportedly, frequent, acute micro-traumas may lead to the development of PTP [12, 13]. The lack of exercise, sleep disturbances, prolonged abnormal posture, impaired joints, visceral conditions, and vitamin deficiencies may predispose individuals to develop PTP [13, 14].

In 2010, a study was conducted at University of Isfahan and evaluated the spinal curvature of students [1]. Accordingly, a high percentage of the students had kyphosis, lumbar hyperlordosis, dropped shoulder and winging of the scapula due to poor posture. Evidence suggests that fatigue, reduced muscle strength, decreased reciprocal antagonist inhibition, and inconsistent muscle activation patterns under load are often present in patients with latent PTP [15, 16]. Additionally, interventional studies have emphasized the relevance of PTP management by ischemic compression, dry needling, laser therapy, myofascial release and several other physical treatments [17].

One of the major causes of shoulder or neck pain is PTP within the neck and shoulder muscles which give rise to fatigue, weakness, pain, and impaired function. Hence, the cause of mild kyphosis in young students is likely their posture while studying, using the computer and mobile phones, and resting. Thus, faulty posture can lead to shoulder and neck pain. In this context, numerous studies have demonstrated that faulty posture can lead to the development of PTP in muscles [7, 18-21]. However, to the best of our knowledge, no study has been conducted to date to examine the association of PTP in young university students with normal thoracic posture versus subjects with mild thoracic kyphosis. Accordingly, this study examines the extent of PTP in the shoulder and scapular regions of two groups of young university students with normal versus mild kyphotic postures.

Materials and Methods

Study design and setting

This cross-sectional study assessed and compared young PT students' trigger points in the shoulder and scapular areas between November 2018 and March 2019. The setting was the Department of Physical Therapy, School of Rehabilitation, Shiraz University of Medical Sciences. Shiraz City, Iran.

Participants selection

This study used the convenience sampling method among PT students of both genders. The sample size consisted of 60 students in the age range of 18 to 25 years. They were divided into two groups of 30 (15 males and 15 females). Also, we carefully reviewed each subject's medical chart obtained from their physician or local hospitals or healthcare centers before making a pertinent diagnosis on whether the thoracic spine was kyphotic or normal. Based on the study criteria and the past medical history, the subjects were divided into two groups. Subjects in the first group were diagnosed with mild thoracic kyphosis while participants in the second group were designated as having normal thoracic posture.

Inclusion criteria

Students with a thoracic kyphosis of greater than 40 degrees were assigned to the mild kyphosis group and those with a kyphosis of 20-40 degrees were assigned to the group with normal posture [1].

Exclusion criteria

Students with any of the following medical or surgical histories were excluded from the study: 1) A history of surgery on the spine or the upper extremities due to any cause; 2) Neurovascular injuries to the neck and upper extremities; 3) Trigger points caused by any predisposing factor, such as vascular problems, hyperthyroidism, cardiopulmonary diseases, anemia, acute or chronic viral disease, and allergies; 4) Severe kyphosis and gibbous deformity; athletes with shoulder and or neck pain [22, 23].

Data collection

Demographic data, such as gender, age, height and weight, were collected using a standard questionnaire developed for the study.

Study measurements

Two of the authors were involved in taking measurements, with a focus on the evaluation of the subjects' kyphosis in degrees and their trigger points in shoulder and scapular muscles, pain, and pressure pain threshold (PPT). The kyphosis assessment was done in degrees, using a flexible ruler, while the trigger points were documented based on the method by Simon et al. [24]. Lastly, the qualitative evaluation of pain was achieved using a visual analog scale (VAS) and the PPT was measured with a digital pressure algometer.

Evaluation of kyphosis

The angular degree of each subject's thoracic kyphosis was measured by the flexi-curve method [25]. This is a low-cost and practical method with acceptable reliability and validity. Each subject was first asked to stand barefooted, with their feet 15 cm apart, by placing the body weight evenly on both feet. A flexible ruler was molded and held onto the subject's spinal column at midline, and its contour was drawn immediately on a large piece of paper. We used the Equation 1 to convert the collected kyphosis measurements from the subjects to degrees:

1. $\theta=4\times[\text{Arc tan}(\frac{2H}{L})$

Where "L" represents the distance between two spinous processes to the nearest millimeter, "H" is the distance of a perpendicular line drawn from "L" to the kyphosis curvature. This method has been reported as valid at the intraclass correlation coefficient=0.91 and reliability of intraclass correlation coefficient=0.87 by two earlier studies [25, 26].

Trigger points evaluation

Before the study, both examiners were trained by an expert supervisor skilled in myofascial pain assessment and clinical management. They were prepared well to conduct the study, practiced supervised palpation proficiency, and learned to quantify the amount of pressure on palpation that reliably reproduced the subjects' symptoms of trigger points. The evaluation of the subjects' trigger points over the shoulder and scapular regions was explicitly done on muscles as the site of these points. These muscles were the upper trapezius, supraspinatus, infraspinatus and anterior fibers of the deltoid and teres major. Both examiners used the techniques previously described by Simon et al. [24] for the evaluation of trigger points in these muscles [6]. To determine the presence of a trigger point, the examiners palpated the muscles and looked for a tight and nodular band in each of the muscles. Upon this maneuver, typical referred and spontaneous pain was considered an active trigger point. Local pain and tenderness were considered latent trigger points. For each trigger point spot, the examiner compressed the nodule and asked the subject to describe the nature of the induced pain at each spot.

Pain evaluation

The subjects were asked to report the severity of their shoulder and scapular pain by pointing out a VAS. This is one of the most common methods to assess pain severity subjectively. This scale is 10 cm in length marked with numbers 0 to 10. Accordingly, 0 represents no pain while 10 indicates intolerable and intense pain. This method is reliable (r=0.94) in the pain assessment literature [27].

Pain pressure threshold evaluation

Pain pressure threshold evaluation was measured using a handheld digital pressure algometer with a 1 cm^2 probe area and perpendicular pressure at a rate of approximately 1 $kg/cm^2/s$ on the trigger points. This algometer consisted of a pistol handle and a rod with a pressure-sensitive gauge at the tip. If multiple trigger points occurred in the same muscle, the examiner asked the subject to report the most sensitive spot. When the subject reported their pain onset, the examiner recorded the corresponding number. This method is also highly reliable at intra-rater and inter-rater levels [28].

Statistical analyses

We used the SPSS software, version 25 to analyze the study data. Descriptive statistics were used for the Mean±SD. The normal distribution of the dataset was examined by the Shapiro-Wilks test, while an independent t-test was used to compare the pain and PPT scores between the two groups. Also, the Mann-Whitney test was used to compare both the kyphosis in degrees and the active and latent trigger points between the two groups. The statistical significance was set at $P<0.05$.

Results

A total of sixty young students participated voluntarily in this study. The designation of mild kyphosis or normal thoracic posture in each case was based on the data from clinical examinations and careful measurements, together with pertinent evidence we could find upon a review of each subject's past medical history. Hence, the subjects were divided into two groups 30 each. Individuals in the first group were diagnosed with mild thoracic kyphosis while those in the second group were designated as having normal thoracic posture. The basic demographic features of the subjects are summarized in Table 1.

According to Table 1, there were no significant differences between the two groups concerning age, weight, and height. The results of the independent sample t-test indicated significant differences in pain intensity ($P<0.001$) and PPT ($P<0.001$) between the two groups. The results of the Mann-Whitney test showed significant differences in the degrees of kyphosis ($P<0.001$) and latent trigger points ($P=0.02$); however, no significant differences were detected for active trigger points ($P=0.823$) between the two groups (Table 2).

Discussion

This study compared the intensity of trigger points in the shoulder and scapular regions between two groups of young university students with mild kyphosis or normal thoracic posture. The results indicated significant differences in latent trigger points but not active ones between the two groups. Also, the two groups had significant differences in pain intensity and PPT. As far as our prior

Table 1. Demographic characteristics of the study groups

Data Category	Mean±SD		P
	Kyphotic Spine	Normal Spine	
Age (y)	21.13±1.36	21.87±2.19	0.126
Weight (kg)	60.63±9.42	66.67±16.20	0.084
Height (cm)	161.62±7.55	160.45±4.55	0.52

Abbreviations: kg: Kilogram; cm: Centimeter; SD: Standard deviation.

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literature review is concerned, this is the first study that examined the presence and intensity of trigger points in young subjects with mild kyphosis versus subjects with normal thoracic postures. Thus, we could not compare our findings with those of earlier studies on this topic.

Our results revealed a greater number of latent trigger points in the shoulder and scapular muscles of the kyphotic group than those with normal postures. Two studies have previously established a connection between abnormal posture and the likelihood of developing trigger points [7, 21]. Details of our literature review appeared in the first section of this article. The findings of the earlier studies confirmed that postural stressors play a significant role in the development of trigger points. In this context, previous research has suggested that biomechanical stressors have a major role in the development and aggravation of trigger points in the peroneus longus muscle [29]. Further, recent studies have reported that abnormal posture leads to muscular dysfunction in the cervical and thoracic regions. The dysfunction is likely to place stress on muscles, articular surfaces, and spinal nerve roots, mainly at cervical and thoracic spinal segments, resulting in muscular imbalance, pain, and a limited range of motion [30, 31]. In this context, we demonstrated that kyphotic students' trigger points were higher than those with normal thoracic postures.

Some studies indicate that latent trigger points can cause dysfunctional muscle activation patterns and may be a predisposing factor for future disorders [23, 32]. Therefore, it can also cause abnormal postural changes and may lead to the development of trigger points, ultimately creating a vicious cycle. Cimbiz et al. reported that forward head posture, round shoulders, and kyphosis were commonly observed in patients with myofascial pain syndrome. These postural deviations from normal posture probably contribute to the development of trigger points manifest in the lower cervical and occipital areas and the supraspinatus and trapezius muscles [18]. Furthermore, faulty posture and trigger points may coexist in a mutual relationship. Bad posture perpetuates trigger points, likely leading to faulty posture [33]. As the scapula moves along the thoracic cage, it is situated in internal rotation with greater anterior tilt, increasing the curvature of thoracic kyphosis [34]. Therefore, the two areas can affect each other concerning the trigger points and are linked to the severity of thoracic kyphosis [26].

Table 2. Between-group differences in the degrees of kyphotic curvature, latent and active trigger points, and pressure pain threshold

Measurement	Mean±SD		P	Median	Interquartile Range
	Mild Kyphosis	Normal Spine			
Kyphosis (degree)	43.23±1.57	36.15±2.34	<0.001	42.1000	3.98
Latent trigger point (number)	2.37±1.27	1.47±0.51	0.02	2.00	3
Active trigger point (number)	1.25±0.45	1.20±0.45	0.823	1.00	1
Pain (VAS)	3.78±1.38	2.53±0.90	<0.001	4.0000	1.55
PPT (N)	23.25±3.84	28.54±3.33	<0.001	23.6000	4.85

Abbreviations: N: Newton; VAS: Visual analog scale; PP: Pressure pain threshold.

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In a study conducted on scapular muscle positioning and concurrent trigger points found in university students and staff, it was suggested that trigger points initially appeared in the trapezius muscle [35]. Another study has shown that moderate physical activity is associated with a lower prevalence of trigger points among university students [36]. This is consistent with the results of our study, where we found many trigger points in the shoulder and scapular muscles. Thus, some paraspinal and shoulder muscles may become shorter while others lengthen. Therefore, inappropriate balance among these muscles leads to improper posture, which in turn promotes the development of trigger points. Consistent with our results, Kamali et al. [19] have demonstrated that the high incidence of forward head posture in tall persons, especially in high school girls, is due to their habits of holding their trunk in a mild kyphosis with the shoulders rounded, hence the development of the trigger points in these young students [19].

A former study [37] examined the prevalence of trigger points and forward head posture during exam time versus mid-semester in PT students. This study found greater numbers of trigger points in the students' shoulder and neck muscles during exam time than in mid-semester [37]. The increase in trigger points during exam times might likely be due to the stressful effect of exams and keeping abnormal posture, as the students spent more time holding themselves in bad posture while studying for their exams.

Further, Alaca et al. have reported that addiction to the internet and social media, as a growing problem, may lead to musculoskeletal issues with negative consequences for the level of people's physical activity, musculoskeletal dysfunctions, and even the development of depressive disorders [38]. Also, Kalichman's study has shown that students develop significantly more trigger points and pain during the exam period than during semesters [37]. Further, Gerber et al. suggested that adults with pain associated with active trigger points had significantly greater pain than those without pain [22]. Consistent with our pain assessment results by VAS, Cimbiz [18] reported that the VAS score in students with trigger points was significantly greater than in students with normal postures.

Recent histopathological and electrophysiological studies have shown that trigger points block blood circulation by compressing the local capillaries, reducing blood supply to the involved tissues and leading to an insufficient energy crisis. The compressed tissues release chemicals, such as bradykinin, serotonin and substance P, all of which stimulate the local nociceptors and give rise to localized and or referred pain [39].

Other studies have suggested that patients with an intense, non-traumatic complaint of pain are likely to have kyphotic posture [40, 41]. Griegel-Morris et al. [42] have consistently demonstrated that subjects with round shoulders and kyphotic posture have a greater chance of developing cervical joint pain and or headaches [42]. Conversely, Pacheco [43] has reported a significant difference between neck pain and forward head posture in asymptomatic students with neck pain. The current study's findings indicated that latent trigger points were present in significantly greater numbers in the kyphotic subjects than in the normal ones. However, the mean pain intensity scores were not significantly different at the trigger points between the two groups.

Future research is warranted to confirm the true relationship and correlation between trigger points and abnormal posture. Our findings also demonstrated that the PPT in the kyphotic group was lower than that found in subjects with normal postures. This contention was also consistent with the findings of several earlier studies [22, 23, 44].

Recommendations for future studies

Given our current findings, we recommend that preventative programs consisting of proper physical activity and exercise should be provided to university students during academic semesters. Indeed, management of trigger points requires identification and control of multiple factors, such as posture, body mechanics, psychological conditions, and or poor sleep [45]. Such an approach will help prevent or minimize the prevalence of musculoskeletal and postural issues among university students. Also, future studies are recommended to investigate other potential factors and mechanisms involved in developing kyphosis in university students.

Conclusion

This study's results indicate a significantly greater number of trigger points in students with mild thoracic kyphosis than in those with normal spine postures. Consistent with the findings of previous studies, the current study results suggest that kyphotic posture can cause muscle imbalance and contribute to the development and or severity of trigger points pain around the shoulder and scapula areas. Further studies on larger sample sizes are warranted to confirm the association or correlation of mild kyphosis with the presence and development of trigger points in subjects of both genders at different age brackets.

Limitations of the study

This cross-sectional study has collected preliminary data to support future research on the relationship of mild kyphosis with bodily trigger points in young adults. However, this study faced at least two limitations. Firstly, the examiners were not blind to the students' posture. This might have caused bias in their interpretation of the clinical findings. Secondly, the results of the current study described the relationship between young age (a mean of 21 years) and trigger points. Trigger points in individuals at different age brackets may have a varying association with their postural impairments.

Ethical Considerations

Compliance with ethical guidelines

The study protocol was approved by the Ethics Committee of Shiraz University of Medical Sciences (Code: IR.SUMS.REHAB.REC.1397.001). Each subject was oriented around the purpose and methods of the study. They also reviewed a set of relevant handouts and subsequently signed an official informed consent form for their participation.

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Authors' contributions

Supervision: Shohreh Taghizadeh; Writing the original draft: Seyedeh Narjes Safavi; Conceptualization, data analysis, review, editing and final approval: All authors.

Conflict of interest

The authors declared no conflict of interest.

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