MMP15

Effects of Bicycle Types in Exercise Training on Upper Trapezius Pressure Pain Threshold in Female Office Workers with Myofascial Pain Syndrome

ผลของชนิดของจักรยานในการฝึกออกกำลังกายต่อความรู้สึกกดเจ็บขั้นต่ำบริเวณบ่าส่วนบนในพนักงานออฟฟิศเพศหญิงที่มีอาการปวดกล้ามเนื้อและเนื้อเยื่อพังผืด

Atita Kokanruad (อาทิตา ก่อการรวด)* Areerat Suputtitada (อารีรัตน์ สุพุทธิธาดา)**
Sompol Sanguanrungsirikul (สมพล สงวนรังศิริกุล)***

ABSTRACT

The aim of this study was to examine the effects of bicycle types in exercise training on pressure pain threshold (PPT) in female office workers with myofascial pain syndrome (MPS). Twenty-four participants were randomized divided into 3 groups (n=8 each); control, bicycle A (seated upright on a stationary bike) and bicycle B (seated forward flexion on the hybrid bike). All participants have measured the PPT before and after performing the typing task (30min) which tested before and after training and 2-week follow-up. The bicycle group performed the exercise at 50-70% heart rate reserve (HRR) 30min/day, 3 days/week while control group performed the stretching exercise (home program) for 3 months. The results showed that PPT was significantly increased in three groups ($P<0.05$) but there were no between-group differences ($P>0.05$). Therefore, both cycling exercise at moderate to high intensity (50-70%HRR) for 3 months can improve PPT in female office workers with MPS.

บทคัดย่อ

การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อศึกษาผลของการออกกำลังกายโดยการปั่นจักรยานต่อความรู้สึกกดเจ็บขั้นต่ำบริเวณกล้ามเนื้อบ่าส่วนบนในพนักงานบริษัทเพศหญิงที่มีอาการปวดกล้ามเนื้อและเนื้อเยื่อพังผืด จำนวน 24 ราย สุ่มแบ่งเป็น 3 กลุ่ม คือ กลุ่มควบคุม กลุ่มปั่นจักรยาน A (นั่งหลังตรงบนจักรยานอยู่กับที่) และกลุ่มปั่นจักรยาน B (นั่งก้มตัวไปด้านหน้าบนจักรยานไฮบริดจ์) อาสาสมัครจะได้รับการวัดระดับความรู้สึกกดเจ็บขั้นต่ำก่อนและหลังพิมพ์งาน ซึ่งทดสอบก่อนและหลัง 3 เดือน และติดตามผล 2 สัปดาห์ กลุ่มควบคุมจะได้รับโปรแกรมยืดกล้ามเนื้อ ขณะที่กลุ่มปั่นจักรยานจะออกกำลังกายที่ระดับปานกลางถึงหนัก 30นาที 3ครั้งต่อสัปดาห์ เป็นเวลา 3 เดือน พบว่าระดับความรู้สึกกดเจ็บขั้นต่ำเพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ ทั้ง3กลุ่ม ($P<0.05$) แต่ไม่มีความแตกต่างระหว่างกลุ่ม ($P>0.05$) จึงสรุปว่าการออกกำลังกายโดยการปั่นจักรยานทั้งสองชนิดที่ระดับปานกลางถึงหนัก (50-70%HRR) เป็นเวลา 3 เดือนสามารถเพิ่มระดับความรู้สึกกดเจ็บขั้นต่ำในพนักงานออฟฟิศเพศหญิงที่มีอาการปวดกล้ามเนื้อและเนื้อเยื่อพังผืด

Keywords: Pressure pain threshold, Myofascial pain syndrome, Heart rate reserve
คำสำคัญ: ระดับความรู้สึกกดเจ็บขั้นต่ำ อาการปวดกล้ามเนื้อและเนื้อเยื่อพังผืด ชีพจรสำรอง

** Student, Master of Science Program in Sports Medicine, Faculty of Medicine, Chulalongkorn University*
*** Professor, Department of Rehabilitation Medicine, Faculty of Medicines, Chulalongkorn University*
**** Associate Professor, Department of Physiology, Faculty of Medicines, Chulalongkorn University*

Introduction

Musculoskeletal symptoms are common health problems among working-age people. Especially with people who have prolonged computer use that consisting of repetitive movement and prolonged awkward posture (Larsson, 2007). This position causes the lower-level static exertions of the muscle (Hoyle et al., 2011; Treaster et al., 2006) and trigger point occurred in the muscles leading to a myofascial pain syndrome (MPS) which is normally found in the upper trapezius muscle (Cerezo-Tellez et al., 2016). It has been reported that the muscle with trigger point has lower pressure pain threshold (PPT) than the normal muscle (Sluka, 2009).

There are many treatments to restore and manage the MPS. For example, trigger point injection, acupuncture, postural and ergonomic modification, physical therapy, stretching, and exercise. The previous study has suggested that the exercise can improve muscle flexibility and functional status, optimize mood and relieve pain in both healthy and unhealthy people (Borg-Stein, Laccarina, 2014). Aerobic exercise at moderate to high intensity can increase PPT, pain tolerance and also reduce pain intensity rating during and after exercise which is a systemic effect. In addition, the increase in PPT may be due to the secretion process of ß-endorphin before and after exercise (Andersen et al., 2008), increase blood flow and tissue oxygenation to non-working muscles during aerobic exercise (Andersen et al., 2010). And the PPT in female patients with fibromyalgia was tended to increase ($P>0.05$) but had similar cardiovascular adaptations to 12-week moderate-intensity endurance exercise as healthy controls (Bardal et al., 2015)

Nowadays, Cycling has become a popular aerobic exercise. Cycling with relaxed shoulder has been shown that the pain intensity, measuring by visual analog scale (VAS) was significantly reduced ($P<0.01$) after 10 weeks of bicycling training in female participants with trapezius myalgia (Andersen et al., 2008). Moreover, PPT in female participants with fibromyalgia was significantly increased ($P<0.001$) (Hooten et al., 2012) after 3 weeks bicycling training.

The upper body muscle activities were sub-maximal intermittently active to push and pull the handlebar during bicycling. This increases blood flow with sufficient oxygen that can maintain aerobic energy metabolism to the active and inactive muscles (Jobson et al., 2013; McCormick et al., 2014). The previous study showed that cycling can increases oxygenation of resting neck/shoulder muscles in the female with and without trapezius myalgia (Andersen et al., 2010). However, several types of bicycles (e.g. road bike, mountain bike, hybrid bike and stationary bike) can lead the different cyclist's position (Chen, He, 2012) The Monark bike is one of the stationary bikes that usually used in the research and laboratory and similar to the bike used in fitness which the cyclist seated upright and another one is hybrid bike that mixed model of mountain bike and road bike which is seated forward flexion to reach the handlebar. These positions may affect pain reduction.

It is interesting that the exercise may play an important role in PPT adaptation. However, there are a few studies on effects of bicycling exercise in myofascial pain syndrome which had similar clinical features to fibromyalgia and it is interesting that how a different kind of bike will effect on the upper trapezius PPT. Therefore, the aim of the present study is to examine the effects of bicycle types in exercise training on upper trapezius pressure pain threshold (PPT) in female office worker with myofascial pain syndrome (MPS).

Objectives of the study

To examine the effects of bicycle types in exercise training on upper trapezius pressure pain threshold (PPT) in female office worker with myofascial pain syndrome (MPS).

Methodology

Twenty-four female office workers with myofascial pain syndrome were recruited into the study. The participants met the following criteria: (1) pain at upper trapezius muscle in the dominated side (VAS=4-6), (2) pain at least 3 months, (3) no history of upper extremities, neck, shoulder and spine problems for at least 1 year before entering the study. Participants with (1) secondary trigger points (e.g. leg length discrepancy, cervical spondylosis), (2) latent trigger points, (3) uncontrolled hypertension, (4) bicycling exercise more than 3 days/week, (5) overhead sports, (6) rheumatic inflammatory disease, (7) fibromyalgia and (8) history of cardiovascular, pulmonary and metabolic diseases were excluded from the study. All participants gave their informed consent, which informed The Declaration of Helsinki, and was approved by The Ethics Committee of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand (IRB No. 582/59).

The participants were divided into 3 groups by a computer-generated random number sequence to control group (n=8), bicycle A (n=8) and bicycle B (n=8). The Control participants were asked to maintain their regular level of physical activity during the 12-week period. Before the assessments, participants were asked to abstain from vigorous exercise for 24 h, caffeine for 6-8 h and alcohol for 24 h. Compliance to these requests was confirmed verbally at the start of the session and during attending the study. The participants were asked to abstain from any other treatment, yoga and overhead sports (e.g. badminton, volleyball, tennis).

During the first, second (after 3 months) and 2-week follow-up typing task, the participants have performed the pressure pain threshold (PPT) assessment before and after completed typing task. PPT was measured by a force transducer (UFI 1030, USA) connected to the Biopac system (MP100, USA) with a probe size of 1 cm^2 in Figure 1. Before the measurement, the device was calibrated with a weight of 1kg, 3kg and 5 kg. PPT was measured bilaterally at upper trapezius muscles (UT). The probe of the force transducer was held perpendicular to the skin. Participants were instructed to give a verbal command of ''stop'' when the sensation of pressure turned to pain. Participants were prone lying by the head facing the opposite side to stretch the UT and the mean of 3 measurements was used to determine PPT at each site. Pain rating was assessed by visual analog scale (VAS; 0–100 mm) anchored by "no pain at all" and "worst pain imaginable"

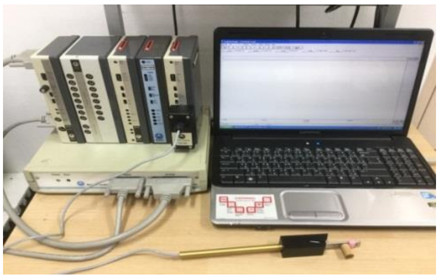

Figure 1 A force transducer (UFI 1030, USA) connected to Biopac system (MP100, USA) with a probe size of 1 cm^2.

The workstation included a standard computer desk with an adjustable slide-out tray for keyboard and the chair with the armrest. The participants were instructed to adjust the keyboard tray and posture to assume a comfortable position, with hip, knee, elbow joints approximately 90° each participant performed the same task of copy typing in 30 minutes. The participants were instructed to work at their normal pace and ignore any typing errors made.

The exercise training was performed with the participants in bicycle A group seated upright on a cycle ergometer (Ergomedic 828E, Monark, Sweden). The arms placed on the handlebar with the relaxed shoulder while the bicycle B group seated forward flexion on the hybrid bike (Fx Series, Trex, USA). The arms placed on the handlebar with the elbows slightly extension and the upper-torso angle approximately 60 degrees. Both groups performed three times per week for 30 minutes at 50-70% Heart rate reserve (HRR) and maintain the cadence 50-60 rpm. 5-minute warm-up and cool-down were ensured for each session. Participants were required to complete a minimum of 34 exercise sessions to be included in the study. The HRR was calculated using the following the Karvonen method to determine exercise intensity:

$$\text{Target heart rate (THR)} = [(\text{Age predicted } HR_{max} - HR_{rest}) \times \%\text{intensity}] + HR_{rest} \qquad (1)$$

Where HRmax is age-predicted maximum heart rate (220-age), HR_{rest} is resting heart rate before exercise.

The control participants performed stretching exercise as a home program which focused on upper body muscles (e.g. upper trapezius, levator scapulae, scalenes, suboccipital, rhomboid, sternocleidomastoid, latissimus dorsi and back extensor) maintaining stretched position for 30 seconds, 3 times/week for 30 minutes.

Changes in dependent variables over time within groups and differences between groups at the same times were analyzed by using repeated-measures analysis of variance with a corresponding post hoc Bonferroni-corrected *t*-test. The difference was significant at P-value 0.05.

Results

Baseline

Twenty-four female participants were randomly assigned to control (n=8), bicycle A group (n=8), bicycle B group (n=8). There was no significant difference in demographic data such as age, BMI, Work hours, Typing speed, VAS (P>0.05) among three groups in Table 1.

Effect of training on PPT after typing task (30min)

There were no significant between groups in PPT at baseline (pre), after first typing (post1), after 3 months (post2) and 2-week follow-up (post3) (P>0.05). However, PPT in control, bicycle A and bicycle B group were significantly decrease from 1.27 ± 0.06 to 0.98 ± 0.58 (P=0.006), 1.64 ± 0.67 to 1.23 ± 0.67 (P=0.035) and 1.35 ± 0.45 to 1.02 ± 0.48 (P=0.021) after the first typing task (post1) respectively Moreover, after 3 months training (post2) the PPT were significantly increase to 2.23 ± 0.71 (P=0.006), 2.49 ± 0.79 (P=0.005) and 2.12 ± 0.75 (P=0.009) and 2-week follow-up (post3) and tend to decrease but not significantly different (P>0.05) in 2-week follow-up (post3) in Figure 2.

Effect of training on pain rating after typing task (30min)

There were no significant time effects within groups in Figure 3. However, a significant time effect was found (P=0.026) with an increase mean pain rating (VAS) following first typing task (30 minutes) from 52.32 ± 4.16 to 58.10 ± 4.58 and significant decrease following 3 months training to 46.54 ± 4.42 mm (P=0.045) in Figure 4.

Table 1 Demographic characteristics according to control and bicycling groups (Mean ± SD)

Characteristics	Control group (n=8)	Bicycle A group (n=8)	Bicycle B group (n=8)
Age (years)	30.25 ± 5.15	30.50 ± 3.63	30.38 ± 4.50
BMI (kg/m^2)	21.09 ± 2.30	21.36 ± 2.53	21.43 ± 4.50
Working hours per day (hours)	8.50 ± 1.41	7.88 ± 2.17	8.13 ± 1.24
Working hours per week (hours)	5.13 ± 0.64	5.13 ± 0.13	5.50 ± 0.76
Typing speed Thai (words/minute)	21.50 ± 5.15	21.25 ± 7.44	20.63 ± 9.43
Typing speed English (words/minute)	20.86 ± 6.69	18.13 ± 5.30	16.88 ± 3.72
VAS (mm.)	46.23 ± 12.77	59.06 ± 18.47	51.31 ± 17.21

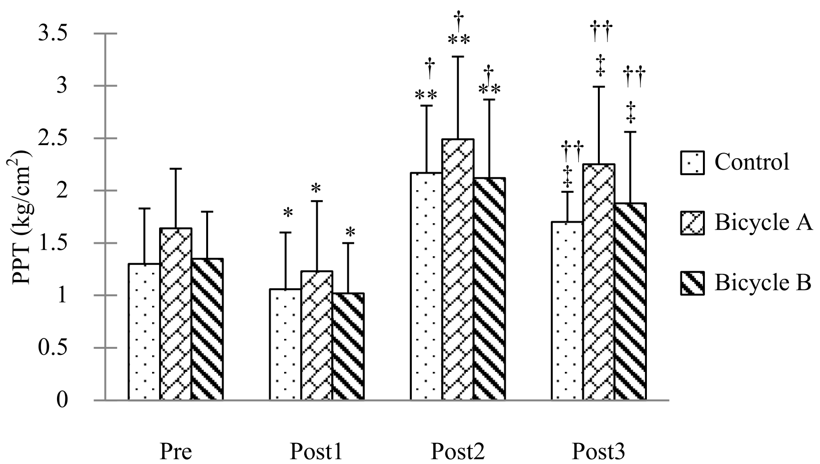

Figure 2 Changes in PPT at upper trapezius muscle across time in three groups and between bicycle A and bicycle B; * P<0.05, (pre-post1); ** P<0.05, (pre-post2); ‡ P<0.05, (pre-post3); † P<0.05, (post1-post2); †† P<0.05, (post1-post3)

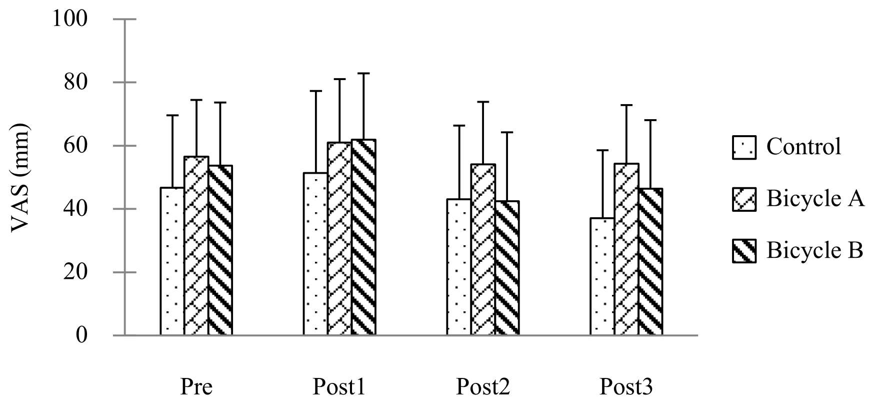

Figure 3 Changes in VAS (Mean ± SD) in each group

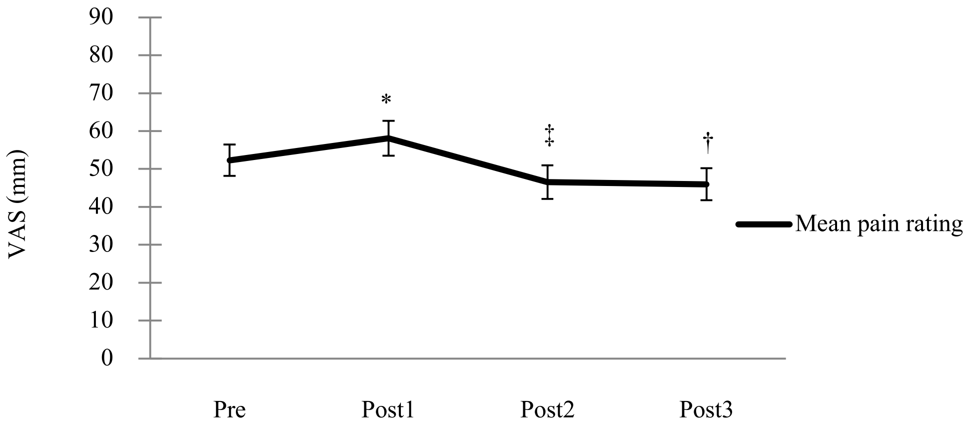

Figure 4 mean pain rating of three groups (mean ± SD) at upper trapezius muscle across time; * P<0.05, (pre-post1); ‡ P<0.05, (post2-post3); † P<0.05, (post2-post4)

Discussion

Since the aim of this study was to examine the effects of bicycle types on PPT in female office workers with MPS. We found that both bicycle types increase PPT while decreasing VAS at upper trapezius muscle. It was obvious that the cycling exercise at moderate to high intensity (50-70%HRR) can improve pain intensity and the effects continually for 2-week after exercise.

Indeed, exercising non-painful parts of the body could have a pain relieving effect in myalgia patient by reducing pain sensitivity in the affected muscles(Lannerster, Kosek, 2010). In the previous study, The incremental cycle exercise had pain reducing effects on PPT at multiple body sites (Meeus et al., 2010). The VAS in trapezius myalgia participants immediately decreases after cycling exercise without holding the handlebar on a Monark bicycle session (20 minutes) 1h per week for 10-week but the level of pain was back to levels that were not significantly different from the pre-training session (Andersen et al., 2008). This may due to the duration of each exercise. In this study, the duration of cycling exercise was 30 minutes, 3 times/ week for 3 months which the body was adapted to the aerobic effects.

There are multiple mechanisms that can explain the effect of exercise-induced hypoalgesia (EIH). Although the exact mechanisms remain unknown, one of the most mechanisms is the activation of the endogenous opioid system during exercise that reduces pain perception following exercise. The released opioids can act at the pain modulation areas in the central nervous system or peripherally on opioid receptors and the muscle contractions activate A-delta and C primary afferent fibers in skeletal muscle can activate the endogenous opioid system. This mechanism reduces pain sensitivity after continuous exercise performed at moderate to high intensity for up to 30 minutes (Koltyn et al., 2014). However, we did not measure circulating levels of opioids and cannot be certain that these levels increased as a result of exercise.

We use Monark and hybrid bike for each bicycle group to perceive the difference of cycling posture, upright and forward flexion. In the upright position, the participants were asked to gripping the handlebar as comfortable as possible while forward flexion position the participants have to forward reaching to the handlebar but the results were no significant difference in PPT between bicycle groups. In the previous study, they found that the upper body muscles were sub-maximal intermittently active to push and pull the hand bar during cycling (McCormick et al., 2014). This increases blood flow with sufficient oxygen that can maintain aerobic energy metabolism to the active and inactive muscles which the previous study showed that cycling can increases oxygenation of resting neck/shoulder muscles in the female with and without trapezius myalgia (Andersen et al., 2010) and the hyperemia will be able to provide the muscles with sufficient oxygen to maintain aerobic energy metabolism (Jobson et al., 2013; McCormick et al., 2014). In addition, when the level of rated perceived exertion increased, the trunk got more swing in both groups that may be providing more blood flow to the upper trapezius muscles. This may cause the results of PPT and VAS in both groups may not be different.

In the present study, we use typing task (30 minutes) to aggravate the symptoms which is a real task in daily life for office workers. We found the statistically decrease in PPT consistent with the previous study that found the changes in PPT of the upper trapezius muscle during continuous work (Treaster et al., 2006; Yoo, 2013). Computer work requires continually forward reaching and repetitive movement. This causes the lower-level static exertions of the muscle and causes more pain. However, after 3 months of exercise and 2-week follow-up the PPT decrease but higher than first typing.

Conclusion

In conclusion, both cycling exercises at moderate to high intensity (50-70%HRR) for 3 months can improve pain intensity and the effects continually after exercise training for 2-week in female office workers with myofascial pain syndrome.

Acknowledgements

The authors would like to thank all of the participants. This work was funded by the 90th Anniversary of Chulalongkorn University Fund and Ratchadaphiseksomphotch Fund, Faculty of Medicine, Chulalongkorn University, Thailand

References

Andersen LL, Blangsted AK, Nielsen PK, Hansen L, Vedsted P, Skogaard G, et al. Effect of cycling on oxygenation of relaxed neck/shoulder muscles in women with and without chronic pain. European journal of applied physiology 2010; 110(2): 389-94.

Andersen LL, Kjaer M, Sogaard K, Hansen L, KryGer AI, Sjogaard G. Effect of two contrasting types of physical exercise on chronic neck muscle pain. Arthritis & Rheumatism (Arthritis Care & Research) 2008; 59(1): 84-91.

Bardal EM, Roeleveld K, Mork PJ. Aerobic and cardiovascular autonomic adaptations to moderate intensity enduran. Journal of rehabilitation medicine 2015; 47(7): 639-46.

Borg-Stein J, Laccarino MA. Myofascial pain syndrome treatments. Physical Medicine & Rehabilitation Clinics of North America 2014; 25: 357-74.

Cerezo-Tellez E, Torres-Lacomba M, Sanchez-Sanchez B, Dommerholt J, Gutierrez-Ortega C. Prevalence of Myofascial pain syndrome in chronic noc-specific neck pain: A population-based Cross-sectional descriptive study. Pain Medicine 2016: 1-9.

Chen YL, He KC. Changes in human cervical and lumbar spine curves while bicycling with different handlebar heights. Work 2012; 41: 5826-7.

Hooten WM, Qu W, Townsend CO, Judd JW. Effects of strength vs aerobic exercise on pain severity in adults with fibromyalgia: A randomized equivalence trial. Pain 2012; 153: 915-23.

Hoyle JA, Marras WS, Sheedy JE, Hart DE. Effects of postural and visual stressor on myofascial trigger point development and motor unit rotation during domputer work. Journal of Electromyography and Kinesiology 2011; 21: 41-8.

Jobson S, Hopker J, Arkesteijn M, Passfield L. Inter-and intra session reliability of muscle activity patterns during cycling. Journal of Electromyography and Kinesiology 2013; 23(1): 230-7.

Koltyn KF, Brellenthin AG, Cook DB, Sehgal N, Hillard C. Mechanisms of exercise-induced hypoalgesia. The Journal of Pain 2014; 15(12): 1294-304.

Lannersten L, Kosek E. Dysfunction of endogenous pain inhibition during exercise with painful muscles in patients with shoulder myalgia and fibromyalgia. Pain 2010; 151: 77-86.

Larsson B. Work related neck-shoulder pain: a review on magnitude, risk factors, biochemical characteristics, clinical picture and preventive interventions. Best Practice & Research Clinical Rheumatology 2007; 21(3): 447-63.

McCormick MC, Watson H, Simpson A, Kilgore L, Baker JS. Surface electromyographic activities of upper body muscles during high-intensity cycle ergometry. Research in Sports Medicine 2014; 22: 124-35.

Meeus M, Roussel NA, Truijen S, Nijs J. Reduced pressure pain thresholds in response to exercise in chronic fatigue syndrome but not in chronic low back pain: An experimental study. Journal of Rehabilitation medicine 2010; 42: 884-90.

Sluka K. Mechanisms and management of pain for physical therapist. USA: International association for the study of pain; 2009.

Treaster DE, Marras WS, Burr D, Sheedy JE, Hart DE. Myofascial trigger point development from visual and postural stressors during computer work. Journal of Electromyography and Kinesiology 2006; 16: 115-24.

Yoo WG. Changes in pressure pain threshold of the upper trapezius, levator scapular and rhomboid muscles during continuous computer work. Journal of Physical Therapy Science 2013; 25: 1021-2.