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Influence of Lumbar Posture on Back Muscles Flexion Relaxation Phenomenon among University Students with Chronic Non-Specific Low Back Pain

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Abstract

Background: Low Back Pain (LBP) is the mosthighly prevalent musculoskeletal disorder. Now, it can be considered the most common cause of disability in the world. Strongconnections have been reported between low back pain prevalence and disturbance of back muscle flexion relaxation phenomenon (FRP).

Aim of Study: To determine the effect of lumbar posture on back muscles flexion relaxation phenomenon during sitting in chronic non-specific low back pain (CNSLBP) among faculty of physical therapy students.

Material and Methods: Thirty male and female university students aged between 18-25 years old were assigned into2 groups, 15 students with chronic non-specific low back painwere assigned into the experimental group and 15 age-matched healthy students were assigned into the control group among students of physical therapy, Misr University for Science and Technology. Surface electromyography (sEMG) was used to assess erector spinae(ES) muscle activation in specific lumbar postures (lordoticand kyphotic) from sitting with specific lumbar flexion angles (0º, 30, 60º, and maximum trunk flexion), the static EMG (lumbar erector spinae data) data for each participant were collected.

Results: There was a significant difference between the study and control group regarding mean EMG values, asback muscles' electrical activity significantly decreased in subjects with low back pain at several lumbar flexion positions in lordotic and kyphotic postures.A kyphotic posture produced very low and unchanged ES EMG values over the full range of trunk flexion, whereas a lordotic posture inducedcomparatively significant lumbar ES activations.

Conclusion: Lumbar posture has asignificant effect on erector spinae activation and consequently the flexion-relaxation phenomenon among students withchronic non-specific low back pain.

Key Words: *Chronic non-specific low back pain – Flexion-relaxation phenomenon – Lumbar postures – Surface electromyography.*

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Introduction

LOW back pain is one of the most prevalent medical conditions among the global population, and both men and women are reportedly affected by this condition equally. The prevalence of LBP has recently increased among many adolescents and young children **[1]**. LBP is categorized into acute and chronic categories, in the former which is known as chronic non-specific low back painis a persistent back and sacrum pain that lasts longer than 12 weeks; it affects 12-33 percent of adults and happens in 85% of cases for unexplained reasons **[2]**.

Although most people recover from the pain quickly, the disability which is the result of such pain mostly leads to a limited range of activity among adults. It is estimated that 5-10% of people experience LBP resulting in severe morbidity, increased health care costs, and individual suffering **[3]**.

Static trunk flexion is epidemiologically considered a risk factor for low back pain. To understand the negative effect of trunk flexion on the human body, the structure and movement mechanisms of the spine during flexion must first be understood **[4]**. LBP was found to be strongly correlated with both rotated and flexed lumbar spine postures. Sitting posture reduces lumbar lordosis compared to standing posture and increases pressure on the ischium, disc pressure, and low back muscle activity, all of which are linked to the onset of LBP. As a result, poor posture is one of the primary causes of the development of low back discomfort **[5]**.

When the maximum range of motion is reached during trunk flexion, back muscular contraction quickly decreases. As part of the load-sharing synergy between two types of lumbar tissues, this is known as the back muscle flexion-relaxation phenomenon (FRP) and denotes a transition of stress from lumbar active tissues (such as muscles) to passive tissues (such as ligaments and fascia). Lumbar postures, specifically lumbar lordosis, or kyphosis, which are regulated by trunk flexion, play a major role in determining these interactions between lumbar active and passive tissues. Lumbar passive tissues elongate and produce more passive forces as the lumbar posture shifts from lordotic to kyphotic. As a result, only minor lumbar active muscular forces are needed to balance the external moment, leading to the FRP **[6]**.

Surface electromyography (sEMG) signals are observed and analyzed as the subject bends toward their maximum voluntary flexion (MVF) in order to evaluate FRP. This flexion-relaxation phenomenon, which generally appears in healthy persons, is frequently altered (sEMG activity continues) in those who are experiencing lower back discomfort. The incidence of FRP was characterized as when the back muscle's EMG values abruptly decreased between two adjacent trunk positions during flexion **[6,7]**.

Since medical students experience LBP with high prevalence **[8]** as a result of long training hours, physical stress and prolonged sitting with faulty posture so, it is essential to find out what is the effect of lumbar posture on flexion-relaxation phenomenon among students with CNSLBP.

Material and Methods

This study was conducted at the Faculty of Physical Therapy, Misr University for Science and Technology, Egypt, participants wereselected by applying a convenient sample selection method and received the assessment protocolat the period from (January 2022 to 10th June 2022).

Using a cross-sectional comparative study design, thirty male and female physical therapy students participated in thisaccording tosample size calculation that was based on power analysis done by using G*power software, utilizing previous similar studies (Flexion Relaxation and Its Relation to Pain and Function over the Duration of a Back Pain Episode). Power set to (0.8) and significance level to (0.05). They were assigned as following, group (A) study group included 15 male and female university students with CNSLBP, group (B) control group involved other 15 healthy university students.

The inclusion criteria: Their age ranged from18-25 years **[9]**. Students with history of CNSLBP localized to lumbar region for at least 3 months **[10]**.

Exclusion criteria: Students with history of back-related condition as Spondylolisthesis, Spinal stenosis, Osteoporotic fracture, disc disease and sacroiliitis, any specific pathology, such as immunologic disorders, rheumatoid arthritis, and systemic diseases, individuals who exhibit severe postural abnormalities, Sensory issues in the lower back, Previous lower trunk injuries or surgeries, Signs of serious pathology, including cancer, myelopathy, and bone fractures thoracic and lumbar spinethroughout the time of the study were excludedfrom this study **[11]**.

All students gave written informed consentprior to participation in the study. This study has been approved by Research Ethical Committee, Faculty of Physic alTherapy, Cairo University (No: P.T.REC/012/003712).

Instruments:

Questionnaire for the identification of back pain for epidemiological purposes **[12]**, Mechanical Weight scale,Visualanalogue scale (VAS), Surface Electromyography (sEMG) Neuro-EMG-MicroTC 9441-014-13218158-2006, Ref: NS062201.001 - SN: 1083QZ - Neurosoft - 5, Voronin str, Ivanovo, 153032, Russia, Bubble Inclinometer, stopwatch.

Experimental protocol:

Students were assigned into 2 groups, 15 healthy controls and study 15 with CNSLBP after filling out a Questionnaire for the identification of back pain for epidemiological purposes **[12]**. The students were initially given a detailed explanation of the experimental protocol; they did not all engage in any vigorous exercise during the experimental period.

Electromyography:

The electromyographic data of the lumbar ES muscle group on each student's dominant side was gathered using an EMG instrument after decreasing skin impedance by alcohol. Over the lumbar ES, recording and reference surface electrodes were placed parallel to the skin (lead-off desired area, 10x10mm^2; center-to-center electrode distance, 25mm) (Fig. 1), approximately 3cm lateral to the L3 spinous process **[4,13]**. In a sitting position, while assuming a lumbar lordotic posture with requested trunk flexion anglestrunk angles (0º, 30, 60º, and maximum trunk flexion) and kyphotic posture with the same angles. Students were instructed to extend their lumbar area outward in the lordotic position, also they were instructed to stretch their lumbar area inward to assume the kyphotic position. The participants maintained constant foot stance postures throughout the test by maintaining their thighs horizontal, knees in a comfortable position, arms hanging freely, and feet shoulder-width apart **[14]**.

Fig. (1): Placement of EMG surface electrodes.

While the students were bending their trunk at requested angles, explained in Table (1) as eight positions from 1 to 8, they maintained every position for 10s. The EMG data of the final 5s of every performed position was collected, with a minimal rest period of 4min allowed between successive trials to minimize possible muscle fatigue and passive tissue creep. All participants repeated each test combination twice, and the mean values were considered for further analysis, we recorded maximum amplitude by micro volt (μv). The static EMG (lumbar ES data) data from 16 test combinations (4 trunk angles x 2 lumbar postures x 2 repetitions) for each participant were collected **[6]**.

Table (1): Lumbar postures and trunk flexion angles while sitting.

Position (1)	Lordotic posture	0º
Position (2)	Lordotic posture	30º
Position (3)	Lordotic posture	60º
Position (4)	Lordotic posture	Maximum trunk flexion
Position (5)	Kyphotic posture	0º
Position (6)	Kyphotic posture	30º
Position (7)	Kyphotic posture	60º
Position (8)	Kyphotic posture	Maximum trunk flexion

Results

All statistical measures were performed using the Statistical Package for Social Science (SPSS) program Version 16 for windows. Prior to finalanalysis, data were screened for normality assumptions and the presence of extreme scores. This exploration was done as a pre-requisite for the parametric calculation of the analysis of difference. Means and standard deviations were calculated for all variables. ANOVA test was used to study differences between study and control groups. Pearson correlation coefficient was used to study correlation between variables. Bar charts and curves were used to display data.

Table (2) represents that was a significant difference between study group and control group with p-value <0.05 regarding mean measurements at positions 2,6 and 8. The means of study group were lower than control group at all positions. At position 2 the mean was 163.89 in study group versus 236.17 in control group while at position 6 the mean in study group was 57.13 versus 87.06 in control group. Also, at position 8 the mean was 53.24 in study group versus 61.38 in control group. These results indicate that in students with CNSLBP, back muscles electrical activity was significantly decreased at positions 2,6 and 8.

Fig. (2) showed that back muscles' electrical activity significantly decreased in students with low back pain at several lumbar flexion positions in lordotic and kyphotic postures. A kyphotic posture produced very low and unchanged ES EMG values over the full range of trunk flexion, whereas a lordotic posture induced comparatively significant lumbar ES activations. Varied lumbar postures also resulted in different patterns of back muscle activation.

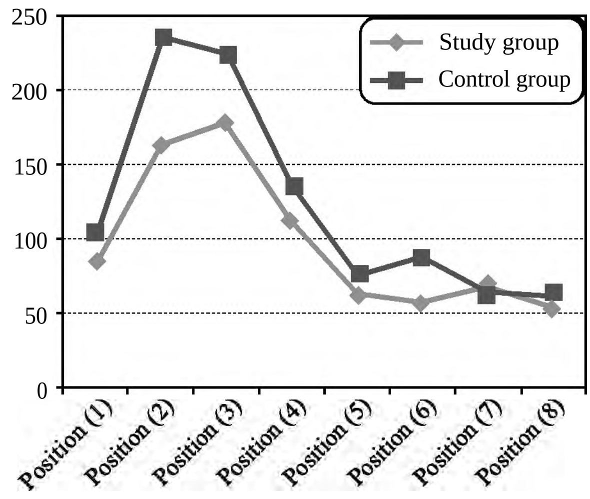

Fig. (2): Measurements of back muscles' electrical activity of study and control groups at different positions.

Table (2): Measurements of back muscles activation of study and control groups at designated positions.

Measurements	Study group (n=15)		Control group (n=15)		F-value	p-value
	Mean	SD	Mean	SD		
Position 1: (0º lumbar flexion with lordosis)	83.24	47.68	99.89	61.91	2.044	.156
Position 2: (30º lumbar flexion with lordosis)	163.89	108.59	236.17	176.12	5.491	.021 *
Position 3: (60º lumbar flexion with lordosis)	178.83	148.32	225.88	138.40	2.420	.123
Position 4: (maximum trunk flexion with lordosis)	112.09	80.82	136.44	115.51	1.343	.250
Position 5: (0º lumbar flexion with kyphosis)	63.01	19.43	74.48	41.74	2.793	.098
Position 6: (30º lumbar flexion with kyphosis)	57.13	15.49	87.06	66.84	8.561	.004*
Position 7: (60º lumbar flexion with kyphosis)	68.08	39.79	64.38	21.41	.302	.584
Position 8: (maximum trunk flexion with kyphosis)	53.24	15.85	61.38	20.78	4.357	.040*

Significant at p-value <0.05.

Discussion

Lumbar posture has significant effects on thoracic and lumbar erector spinae activations, which mainly affect back pain [6]. Numerous studies have reported that flexion relaxation phenomenon is most frequently absent in chronic non-specific low back pain (CNSLBP) patients and reflects a lack of relaxation of the muscles. Absence of muscle relaxation can lead to muscle fatigue [15].

Therefore, this study was conducted to evaluate how different lumbar postures and trunk flexion angles affected the activation of the lumbar erector spinae (ES) and consequently the FRP in university students who had non-specific persistent low back pain, consequently, identify which posture would be better for CNSLBP, particularly with prolonged sitting.

The results of this study showed that back muscles electrical activity significantly decreased in students with low back pain at several lumbar flexion positions during both lordotic & kyphotic lumbar spine posture. A kyphotic posture produced very low and unchanged ES EMG values throughout the entire full ROM of trunk flexion, whereas a lordotic posture resulted in significant lumbar ES activations. Varied lumbar postures also resulted in different patterns of back muscle activation.

Unfortunately, and up to the authors' knowledge, no previous research work studied this area specifically, examining the effect of lumbar posture on flexion-relaxation phenomenon among university students with chronic non-specific low back pain. However, the results of this study were supported by previous research work conducted.

Like the current study results, some studies have reported that when the subjects were seated and flexed their trunk starting from 45 with the lordotic position, the FRP only happened in the lumbar ES. According to this study, people should be cautious about their lumbar position when conducting seated work [6].

Furthermore, another study concluded that myoelectric silence was present during FRP when the trunk was flexed, which is compatible with enhanced load sharing of the passive posterior disco-ligamentous structures [16].

Likewise, previous research revealed that people with a history of pain in prolonged sitting did not alter multifidus activity between the long and short lordotic postures, in contrast to pain-free participants who varied lumbar multifidus activity with changes in lumbar curvature. They also reported that analysis of EMG amplitude during maximum voluntary contraction efforts between groups showed that EMG amplitudes were lower in the LBP than in the control group [17].

Contrary to the current results, other previous study proposed that trunk muscle activation was not a reliable indicator of NSCLBP subgroups in adolescence. Flexion-relaxation in sitting was visible in iliocostalis and thoracic erector spinae for adolescents with NSCLPB but not for healthy controls. Muscle activation and FRP did not distinguish as well between subgroups of NSCLBP and those with and without pain as they did in adults [18].

Conclusion:

From the findings of the current study, it can be concluded that there is a significant effect of lumbar posture on back muscles' electrical activity in students with CNSLBP, hence it affects the flexion relaxation phenomenon.

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تأثير وضعية الفقرات القطنية على ظاهرة الارتخاء العضلى المصاحب للانحناء لدى الطلاب الجامعيين المصابين بألم أسفل الظهر غير المحدد المزمن

ألام أسفل الظهر هى الاضطراب العضلى الهيكلى الأكثر انتشاراً. الآن، يمكن اعتباره السبب الأكثر شيوعاً للإعاقة فى العالم. تم الإبلاغ عن روابط قوية بين انتشار آلام أسفل الظهر واضطراب ظاهرة ارتخاء عضلات الظهر المصاحبة للانحناء.

الهدف من الدراسة : التعرف على تأثير وضعية الفقرات القطنية على ظاهرة ارتخاء عضلات الظهر المصاحبة للانحناء أثناء الجلوس لدى طلبة كلية العلاج الطبيعى المصابين بألم أسفل الظهر غير المحدد المزمن.

مواد البحث وأساليبه : تم تعيين ثلاثين طالباً وطالبة جامعياً تتراوح أعمارهم بين ١٨–٢٥ عاماً فى مجموعتين، حيث تم تعيين ١٥ طالباً منهم يعانون من آلام مزمنة غير محددة فى أسفل الظهر فى المجموعة التجريبية و ١٥ طالبا يتمتعون بصحة جيدة متطابقين معهم مع العمر فى المجموعة الضابطة، بين طلاب العلاج الطبيعى، بجامعة مصر للعلوم والتكنولوجيا. تم استخدام جهاز رسم العضلات بالالكترودات السطحية لتقييم تنشيط العضلات الناصبة للعمود الفقرى فى أوضاع قطنية محددة (مقوس ومحدب) من الجوس بزاويا انثناء قطنية محددة (٠، ٣٠، ٦٠ والحد الأقصى لثنى الجزع)، وتم جمع بيانات الاشارات الكهربية فى الأوضاع الثابتة أوضاع العضلات الناصبة للعمود الفقرى القطنى لكل مشارك.

النتائج : كان هناك فرق كبير بين مجموعة الدراسة ومجموعة المراقبة فيما يتعلق بمتوسط قيم التخطيط الكهربى للعضلات، حيث انخفض النشاط الكهربى لعضلات أسفل الظهر بشكل ملحوظ فى الأشخاص الذين يعانون من آلام أسفل الظهر فى العديد من أوضاع انثناء أسفل الظهر فى الأوضاع المقوسة والمحدبة.

الاستنتاج : وضعية الفقرات القطنية لها تأثير كبير على التنشيط الكهربى للعضلات الناصبة للعمود الفقرى القطنى وبالتالى ظاهرة الارتخاء العضلى المصاحب للانحناء لدى الطلاب الذين يعانون من ألم أسفل الظهر الغير محدد المزمن.