Comparative Analysis of Scapula Position, Balance, and Proprioception in Chronic Low Back Pain Patients and Healthy Individuals

Kronik Bel Ağrısı Hastaları ve Sağlıklı Bireylerde Skapula Pozisyonu, Denge ve Propriosepsiyonun Karşılaştırmalı Analizi

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ABSTRACT

The aim of our study was to analyze the scapula position of healthy individuals and individuals with chronic low back pain and to determine its relationship with balance functioning and proprioception.

Chronic low back pain patients (n=40, age: 31.13) and healthy individuals (n=41, age: 28.37) with similar age and physical characteristics were included in the study. Pain intensity was assessed using a visual analog scale and pain tolerance was assessed using an algometer. Lateral scapular shift test was performed for scapular position assessment. Functionality in activities of daily living was evaluated with the Oswestry Disability Index. Biodex Balance System was used to evaluate the dynamic and static balance of the individuals. Proprioception was measured using an inclinometer device in lumbar flexion and extension positions with eyes open/closed.

As a result of the study, when the difference between healthy and chronic low back pain groups was examined, no significant relationship was found in terms of proprioception (p=0.084), pain tolerance (p=0.64) and scapula position (p=0.570). However, a significant difference was found in the balance parameters between individuals in left foot dynamic (p=0.036), static (p=0.035) and dynamic bipedal (p=0.039).

According to the findings obtained as a result of the study, there were differences in balance parameters between individuals with chronic low back pain and individuals of similar age group. However, no differences were found between scapula position, pain and proprioception. We think that more effective results will be obtained in future studies with older age groups

Keywords: Low Back Pain, Postural Balance, Proprioception, Pain Assessment

ÖZ

Çalışmamızın amacı kronik bel ağrısı olan bireyler ile sağlıklı bireylerin skapula pozisyonunu incelemek, denge fonksiyonellik ve propriosepsiyon ile ilişkisini belirlemek amacıyla tasarlandı.

Çalışma en az 3 ay süreli ağrı şikâyeti olan kronik bel ağrılı (n=40, yaş: 31,13) ve benzer yaş grubu ve fiziksel özelliklerdeki sağlıklı bireyler (n=41, yaş: 28,37) dahil edildi. Bireylerin ağrı şiddeti vizüel analog skala ve ağrı toleransı algometreyle değerlendirildi. Skapular pozisyon değerlendirmesi için lateral skapula kayma testi uygulandı. Bireylerin günlük yaşam aktivitelerindeki fonksiyonelliği Oswestry Disabilite İndeksi ile değerlendirildi. Bireylerin dinamik ve statik dengelerini değerlendirmek için Biodex Denge Sistemi kullanıldı. Propriosepsiyonu, gözler açık/kapalı koşullarda lumbal fleksiyon ve ekstansiyon pozisyonlarında inklinometre cihazı kullanılarak ölçüm yapıldı.

Çalışma sonucumuzda sağlıklı ve kronik bel ağrılı gruplar arasındaki fark incelendiğinde propriosepsiyon (p=0,084), ağrı toleransı (p=0,64) ve skapula pozisyonu (p=0,570) açısından anlamlı ilişki bulunamadı. Ancak bireyler arasında sol ayak dinamik (p=0,036) ve statik (p=0,035) ve dinamik çift ayak (p=0,039) dengede anlamlı fark bulundu.

Çalışma sonucunda elde edilen bulgulara göre kronik bel ağrısı olan bireyler ve benzer yaş grubundaki bireylerde arasında denge parametrelerde farklılık bulundu. Ancak skapula pozisyonu, ağrı ve propriosepsiyon arasında farklılıklar bulunmadı. Gelecekte daha ileri yaş gruplarıyla yapılan çalışmalarda daha etkili sonuçlar elde edileceği düşüncesindeyiz.

Anahtar Kelimeler: Bel Ağrısı, Postural Balance, Propriosepsiyon, Ağrı Değerlendirmesi

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INTRODUCTION

Low back pain is one of the most common problems in daily life. It is known that 70-80% of individuals experience low back pain at least once in their lives. Low back pain brings with it many problems such as functional disability, loss of workforce, medical expenses, and decreased quality of life. Chronic low back pain (CLBP) covers pain that persists for more than 3 months and if left untreated, paves the way for many problems.[1]

CLBP is usually caused by mechanical problems. The mechanical impairment leads to impaired muscle function. Identifying the factors that cause low back pain is important to prevent the disease from becoming chronic. It is known that the endurance and strength of abdominal and lumbar muscles are affected in individuals with low back pain.[2] Pathophysiological causes of CLBP include weakness and deficiency in motor control of the core muscles that regulate mobility and provide lumbar stabilization.[3] When individuals without low back pain and individuals with low back pain are compared, it is seen that individuals with low back pain have smaller muscle size. However, it was found that there was less increase in muscle thickness during contraction of these muscles.[4] According to recent studies on individuals with CLBP, problems in balance and posture control may also occur. In individuals without low back pain, balance control is achieved after interactions between proprioceptive, vestibular and visual systems, whereas in individuals with low back pain, balance problems may be seen in relation to decreased muscle strength and loss of lumbosacral proprioceptive sensation.[4,5]

Latissimus dorsi is one of the most important muscles for the lumbar region and provides stabilization by creating an extensor moment.[6] In individuals with CLBP, latissimus dorsi dysfunction may alter scapular position.[7] During shoulder elevation, scapulothoracic joint movements occur with the movement accompanied by the clavicle.[8] Observed or measured changes in the scapula in the resting position or during active movement are called scapular dyskinesia.[9] Scapular dyskinesia can cause bone and joint problems, neurological problems, soft tissue problems, postural disorders and loss of balance.[10,11] To our knowledge, there is no study investigating the effect of scapula position on balance and functionality in individuals with CLBP. Therefore, the aim of our study was to investigate the effect of scapula position on balance and functionality in individuals with CLBP.

MATERIAL AND METHODS

The research was carried out at Bahçeşehir University involving individuals diagnosed with chronic low back pain (CLBP). Eligible participants were those experiencing low back pain persisting for a minimum of three months. A power analysis was conducted to determine the effect size, resulting in a calculated value of 0.82. Subsequently, 81 participants were selected for the study using the G Power program (version 3.1.9.2) with 95% statistical power and a type 1 error rate set at 0.05. The study comprised two groups: the first group consisted of 40 individuals reporting low back pain for at least three months, while the second group comprised 41 healthy individuals. Comparative analyses were performed between these two groups

Ethical Aspects of the Study

The approval of Bahçeşehir University Health Sciences Ethics Committee E-85646034-604.02.02-62452 was obtained for the study. Clinical trials: NCT05982964. Each participating individual was informed about the study and signed an informed consent form. Inclusion criteria: Individuals between the ages of 18-35 years, individuals with low back pain for at least 3 months for the first group, being a volunteer, not undergoing surgery related to the lumbar region, subjects without lumbar steroid injection in the last 3 months, no visual hearing loss, having low

back pain, subjects without neurological problems. Subjects without tumors and infections in the lumbar region, without musculoskeletal or neuromuscular diseases restricting mobility, and with upper extremity sequelae were excluded. VAS score of 2 and below for the healthy group

Assessment

The demographic information of the participants was evaluated with Demographic Information Form; pain intensity at rest and during activity was evaluated with visual analog scale (VAS); scapular position assessment was evaluated with Lateral Scapular Slide Test (LSST); functionality of individuals in activities of daily living in low back pain was evaluated with Oswestry Disability Index (ODI); static and dynamic balance was evaluated with Biodex Balance System; objective assessment of pain threshold and tolerance of individuals was evaluated with Algometer device; proprioception of individuals was evaluated with digital dual inclinometer. Demographic information: Participants' age, gender, height, weight, education and marital status were recorded anonymously.

Pain assessment: VAS was used to assess pain intensity. Participants were asked to think about the intensity of pain they felt at the time and mark the level of pain they felt on a 10 cm long line. Participants were explained that 0 would be considered 'no pain' and 10 would be considered 'unbearable pain' and were asked to rate their own pain on this scale.[12]

Pressure pain threshold algometer. A pressure algometer is an instrument used to assess pain threshold. The algometer used in this study consists of a metal piston with a disc with a diameter of 1 centimeter at the end, connected to a dial that measures pressure in kilo grams and pounds, with a smallest range of 100 g and 10 kg/cm^2.[13]

Before assessing the pressure threshold, a pressure was applied to the pulse of the thumb as a control. Afterwards, the same trial was applied to the participant and a force was applied at a level to feel pain in order to distinguish between pressure and pain sensation, and the actual assessment was started. The quadratus lumborum muscle was evaluated. The pressure was applied vertically to the muscle where we evaluated the trigger point, increasing by 1 kg/cm^2 every 3 seconds until the participant felt pain. The participants were asked to report when they felt pain during force application with the algometer device. This application was repeated three times and 10 seconds were waited between the measurements and the measurements were averaged.[14]

The evaluation of scapular position was conducted using the LSST (Lateral Scapular Slide Test). This assessment involved three distinct positions. Firstly, the shoulder was positioned neutrally with the arms relaxed at the sides. Secondly, the patient's hands were placed around the waist, with the humerus internally rotated and abducted at a 45-degree angle. Lastly, in the third position, the humerus was maximally internally rotated and abducted at a 90-degree angle. The scapular position was assessed by measuring the differences between both sides in these three test positions. Measurements were consistently taken on the same horizontal plane, spanning from the lower corner of the scapula to the spinous process of the thoracic vertebrae.[15]

A difference of more than 1 centimeter when comparing bilateral measurements is the specific criterion established by Kibler to determine a positive lateral scapular slide test.

Assessment of balance: Static and dynamic postural stability of all individuals included in the study was assessed with the Biodex Balance System (BBS).[16]

A total of three measurements are obtained. For the evaluation of postural stability, a total of 3 tests were performed while the platform was in static position, each period for 20 seconds, giving the participant 10 seconds of rest time in between. In the results obtained, as the score approaches towards 0, the balance is maintained.

Proprioception assessment with digital inclinometer: Inclinometer is an instrument

that records angular movements according to gravity. In our study, inclinometer was used for proprioception assessment. During the measurement, the screen of the inclinometer was placed in the mid-thoracic region. The test was explained to all subjects and the test was started after a trial. Rest intervals of 10 seconds were implemented between each measurement to ensure adequate recovery. Three separate assessments were conducted, with each movement carefully instructed to the participants to ensure proper execution. This method aimed to enhance the accuracy and consistency of the results. Measurements were performed as lumbar flexion and extension while standing with eyes open/closed.[17]

Assessment of functionality. The Oswestry Disability Index (ODI) was used to examine functionality in patients with chronic low back pain. This questionnaire consists of a total of 10 questions. Each question has 6 options and ranges from 0 to 5. Participants are asked to mark the most appropriate option for their individual situation. 50 is the highest score, 1 to 10 points is considered as mild functional disability, 11 to 30 points as moderate functional disability, 31 to 50 points as severe functional disability.[18]

Statistical Analysis

The statistical analysis for this study was conducted using SPSS 26.0 software, which is an acronym for the Statistical Package for Social Sciences, developed in Chicago, Illinois, United States. Various statistical techniques were employed, including descriptive, comparative, and correlation analyses. Nonparametric data were assessed using Mann Whitney-U test, while parametric data were analyzed using the independent samples t-test. Additionally, the Mann Whitney-U test, paired two-sample Wilcoxon test, and Chi-square test were applied to compare values within groups before and after therapy, as well as for nonparametric and categorical data.

RESULTS AND DISCUSSION

A total of 86 people were evaluated in the study. One person did not want to be included in the study and four people were excluded because they did not meet the inclusion criteria. 40 individuals with chronic low back pain and 41 healthy individuals were evaluated within the scope of the study.

Between the low back pain group and the healthy group, there were no statistically significant differences in terms of age, (p=0.327), body mass index (p=0.236), gender (p=0.565) (Table 1). There is no statistically significant difference between low back pain and healthy groups in terms of proprioception differences(p=0.854), pain tolerance right (p=0.064), left (p=0.103) and scapula position measurements(p= 0.507) .

Balance parameters between individuals in left foot dynamic (p=0.036), static (p=0.035) and dynamic bipedal (p=0.039) significant differences. Nevertheless, there were no statistically significant differences between the groups of people with back pain and those who weren't.

Table 1. Comparison of Sociodemographic Characteristics of the Groups

	Low Back Pain Group Mean±SD Median (Min.-Max.) (n:40)	**Healthy Group Mean±SD Median (Min.-Max.) (n:41)**	**p**
Age	31.13±13.40 25(18-63)	28.37±10.79 23(18-58)	0.327
BMI (kg/m^2)	24.80±4.45 24.15 (17-37.2)	23.80±3.70 22.6 (18.6-37.9)	0.236
Gender	24 Female	22 Female	0.565
	16 Male	19 Male	
Dominant Side	35 Right 5 Left	39Right 2 Left	0.912
ODI	29.10±9.96 26(15.5-50)	**NA**	
VAS	6.35±1.61 6(4-10)	**NA**	

Table 2. Comparison of Proprioception, Pain Tolerance and Scapula Positions of the Groups

	Low Back Pain Group Mean±SD Median (Min.-Max.)	Healthy Group Mean±SD Median (Min.-Max.)	p
Proprioception ,Fleksion (°)	149.60±71.11 145(18-255)	145.71±82.04 120 (11-267)	0.854
Proprioception , Fleksion Close Eyes (°)	150.55±73.85 129.5(13-262)	147.16±88.93 130(2.5-315)	0.846
Proprioception , Ekstansion Open Eyes(°)	162.10±64.41 181.5(3-322)	149.80±51.2 165(7-218)	0.093
Proprioception , Ekstansion(°)	161.38±63.52 180(3-318)	157.76±55.33 171(6-260)	0.319
Algometer Right (kg/cm^2)	6.80±2.31 7(2-11)	7.93±2.71 8(2-11)	0.064
Algometer Left (kg/cm^2)	6.90±2.50 7(3-11)	7.89±2.87 8.5(3-11)	0.103
LSST 1. (cm)	7.14±1.36 7(4.5-10.5)	6.96±1.33 7(4.5-10.5)	0.570
LSST 2. (cm)	7.39±1.43 7.25(5-10.5)	7.15±1.50 7(3-11)	0.665
LSST 3. (cm)	6.84±1.60 6.75(4-11)	6.34±1.30 6.5(3-10)	0.195

cm: centimeters, kg: kilogram, p-value < 0.05 SD: standard deviation, Minimum: Min, Max: Maximum

Table 3. Comparison of Groups' Balance

	Low Back Pain Group Mean±SD Median (Min.-Max.)	Healthy Group Mean±SD Median (Min.-Max.)	P
Static double leg	1.29±1.76 0.65(0.2-9.3)	0.98±1.46 0.5(0.2-6.4)	0.056
Static left foot	4.29±3.47 2.8(0.5-15.3)	3.00±2.69 2.3(0.5-11.8)	**0.035***
Static right foot	2.71±1.96 2(0.8-9.3)	2.42±1.90 1.9(0.5-7.6)	0.298
Dynamic double leg	3.30±3.54 2.05(0.5-16.3)	2.20±2.79 1.2(0.4-16.3)	**0.030***
Dynamic left foot	3.71±3.63 2.7(1-19.6)	2.66±3.35 1.7(0.5-19.6)	**0.036***
Dynamic right foot	3.42±4.04 2(0.3-19.4)	2.95±3.20 1.8(0.5-19.4)	0.777

p-value < 0.05, SD: standard deviation, Minimum: Min, Max: Maximum

According to our knowledge at the time the literature evaluation was conducted, there were not enough studies on how the scapula position affects balance and functionality in people with CLBP. Therefore, we believe that assessing balance and functionality will make our study distinctive and different.

Maintaining postural balance in static or dynamic conditions requires a healthy central nervous system, as well as sound sensory and motor functioning.[19] In individuals with CLBP, postural balance may be disrupted by central or peripheral mechanisms. Central and peripheral mechanisms must interact in order to maintain balance. In their study, Henry et al. suggested that individuals with CLBP have abnormal automatic postural coordination indicating altered neuromuscular control.[9,20]

A comparison of the standing on one leg and Y balance test between healthy individuals and individuals with CLBP showed a performance impairment that may affect spinal stability in individuals with CLBP.[21] In addition, individuals with CLBP can modify their motor control strategies to prevent pain sensation.[22] A Brazilian study reported that 27.7% and 22.7% of individuals with CLBP had low back pain-related disabilities and changes in postural balance, respectively.[23] It has also been reported that individuals with low back pain have decreased static balance performance. It has been stated that the balance of individuals with chronic low back pain should be evaluated during treatment planning and balance-oriented applications should be included in the treatment plan.[6] We assessed the balance between healthy people and CLBP as a result of the study. The study's findings showed that healthy people performed better in dynamic bipedal, left foot dynamic, and static balance tests than people with low back pain. However, the results on the right side showed no distinction between the two groups. We believe that this difference was seen because the right side was predominate in the majority of research participants. Despite the lack of significant difference in pain levels, individuals with chronic low back pain may develop compensatory mechanisms that negatively impact their balance. Furthermore, neurological changes associated with chronic

pain can further impair postural control and stability.

In a study by Silva et al., it was found that CLBP had less stable postures than healthy people.[7] Similar to our study, Sherafat et al. evaluated the dynamic balance of 15 individuals with CLBP and 15 healthy individuals in the combined conditions of eyes open/closed and platform stability (levels 5 and 3) using the BBS. As a result of the study, differences were observed between levels 5 and 3.[24] Similar to this study, we used postural stability in our study. In our study, it was observed that balance performance was negatively affected in accordance with the literature. The static left leg stance measurements of the CLBP group were higher than those of the healthy group. Similarly, dynamic double leg and left leg stance measurements of the CLBP group were higher than those of the healthy group. Other measurements were similar between the groups. We used the fourth level of BBS in our study and we think that the different results between the groups are related to the program and level we used.

If there is an impairment in scapular movements, the forces from the lower extremities and trunk cannot be properly transferred to the upper extremities.[10] Laudner et al. suggested in a study that stiffness over the latissimus dorsi muscle affects scapular movement due to its adhesion to the inner edge of the scapula.[25] Taghizadeh et al. investigated scapular positioning in patients with CLBP and found a significant difference between individuals with chronic low back pain and healthy individuals, both on the right and left sides, in the shoulder neutral position and in the shoulder 40°-45° abduction position.[26] The lack of scapular dyskinesia in the subjects may be the reason why there was no difference in LSST between the healthy group and the CLBP group in our investigation. Additionally, there are studies that claim that LSST is insufficient to identify scapular asymmetry in the literature.[28,29] Additionally, one of the reasons for our similarity may be that we don't know the latissimus dorsi muscle strength and stiffness of the people in either group, and that neither group's members have any shoulder pathology. We believe that our findings do not align with the existing literature for the reasons already discussed.

Age, poor proprioception, weak muscles, poor coordination, and other variables can all have an impact on postural balance.[30,31] Meirer et al.[32] found that motor control adaptation in lumbar low back pain causes chronicity of pain, and decreased paraspinal proprioception in individuals with CLBP was associated with reorganization in the motor cortex.

Proprioceptive deficiency has been found to be connected to chronic low back pain in a systematic evaluation.[19] In this study, we used an inclinometer to assess the proprioception of the healthy group and CLBP patients. There was not a significant distinction between the two groups. The similarity between the groups is believed to be due to the fact that proprioception decreases with age and that the CLBP and healthy group in our study consisted of young people in a similar age range.

CONCLUSION AND RECOMMENDATIONS

Conducting studies involving participants from broader age groups, not limited to chronic low back pain sufferers, can potentially unveil more comprehensive insights into the relationship between scapular position, chronic low back pain, and associated factors. Such research might offer a more detailed understanding of how scapular position, pain perception, and balance vary across different age groups.

Long-term studies aimed at tracking changes in scapular positioning, balance, and proprioception over time in individuals with chronic low back pain are crucial. These studies could shed light on how scapular position, balance, and proprioception evolve throughout the course of chronic low back pain. Understanding these changes could provide valuable insights into management and intervention strategies, considering the

potential long-term effects of specific treatment or rehabilitation approaches.

Our study has some limitations. Individuals in both groups represent the young population. Elderly individuals were not included in our study. In addition, scapular dyskinesia was evaluated with LSST in our study, but scapular dyskinesia could have been better evaluated if three-dimensional motion analysis could have been used instead. Additionally, the strength and endurance of the muscles surrounding the scapula were not measured.

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