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Research Article

IS THERE A RELATIONSHIP BETWEEN PAIN, LIMITS OF STABILITY AND SENSORY INTERACTION BALANCE IN PATIENTS WITH LUMBAR DISC HERNIATION? A CROSS-SECTIONAL STUDY

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Abstract: *Lumbar Disc Herniation (LDH) is a disorder causing pain and somatosensory loss. Although the association between pain and postural control in chronic low back pain is known, the relationship between pain and sensory problems with postural control is unknown in LDH, which is one of the most serious conditions among diseases. The purpose of the study was to determine the relationship between pain severity, limits of stability, and sensory interaction balance in patients with LDH. A total of 119 LDH patients, 64 of whom were women and 55 were men, were included in this cross-sectional study. Pain severity and postural control of the patients were measured by using the Visual Analog Scale and Biodex Balance Device, respectively. Limits of Stability and Clinical Test of Sensory Interaction Balance tests were used for postural control evaluation. The results of our study indicated that pain and disability were positively correlated with sensory interaction balance ($p<0.05$) while there was no statistically significant correlation between pain, disability, and limits of stability ($p>0.05$). In patients with LDH, the sensory interaction balance was negatively affected by the increased pain and disability level, while LOS was not. Therefore, in addition to reducing pain and disability, approaches to increase the sensory interaction balance should be adopted in physiotherapy programs for these patients.*

Keywords: *Lumbar disc herniation, Pain, Postural control, Stability limits, Sensory interaction balance*

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1. Introduction

Postural control is the ability to control the body in space to establish orientation and stability. Sensory information coming from proprioceptive, vestibular, and visual systems is used to ensure postural control [1]. In this context, postural control is affected negatively by aging and, neurological and musculoskeletal diseases [2,3]. Chronic low back pain, which is frequently encountered and affects daily living activities, is one of the main musculoskeletal disorders affecting postural control [4].

Lumbar Disc Herniation (LDH) causes chronic low back pain and sensory deficits. Sensory and motor losses that occur in lower extremities may affect postural control in patients with LDH and these impairments cause asymmetric loading to limbs [5]. Previous studies have reported that postural control was reduced in patients with low back pain when compared to healthy people. The decreased somatosensory input due to pain and nerve root compression has been stated as the possible reason for this change in postural control [6-8]. Although many mechanisms affecting postural control in LDH were mentioned; pain intensity, fear of movement due to pain, positive neurological findings, alternative

movement strategies, and reduced muscular condition have also been reported important factors in deteriorating postural control [9-12].

While many studies are reporting that postural control was decreased in patients with low back pain when compared to healthy individuals [13-15], studies that investigate postural control in patients with lumbar disc herniation are limited [16,17]. Although the postural control, which is required to ensure functional activities, was mentioned dynamically or statically in previous studies, postural control has not been studied in detail considering the limits of stability and sensory interaction balance parameters, which include the evaluation of proprioceptive and vestibular systems that are affected by the disease. There is no known study investigating the relationship between pain intensity, disability level, and postural control in patients with LDH. If the correlation between these parameters may be revealed, more necessary evaluation options should be determined and more efficacious treatment strategies may be developed. This study aimed to assist future research and clinicians to choose the most relevant variables that should be taken into account while evaluating and/or managing individuals with LDH.

The present study aimed to investigate the relationship between pain intensity, disability level, and postural control in patients with LDH. We hypothesized that pain and disability are negatively correlated with limits of stability, while positively correlated with sensory interaction balance.

2. Materials and Methods

2.1. Study design

The study was designed as a cross-sectional study and conducted between June 2017 and May 2018.

2.2. Participants

The study included 119 patients over the age of 18, who volunteered to participate in the study. Patients who were admitted to the Neurosurgery clinic with lumbar disc problems, whose disease stage were defined by magnetic resonance imaging, and who was diagnosed at least 6 months ago were included in study. Patients who have a neurological or musculoskeletal disease affecting the lower extremities, vestibular and vision problems likely to affect postural control, have an amputation or use assistive devices, are pregnant, have serious systemic disease in addition to disc problems (tumor, infection, osteoporosis, diabetes mellitus, rheumatological diseases such as Becterew), mental and cognitive disorders that prevent cooperation were excluded.

Ethical statements

Permission was obtained from Dokuz Eylül University Ethical Committee with 2017/15-20 decision number in 08.06.2017 for the study. A written informed consent form was signed by the participants based on the Declaration of Helsinki.

2.3. Procedure

The herniation level and stage of the disease were diagnosed by the neurosurgeon according to Magnetic Resonance Imaging results, and clinical examinations were performed. Patients who accepted to participate in the study and met the inclusion criteria were assessed by the physiotherapist regarding pain severity, disability levels, and postural control, and the data were recorded.

Visual Analog Scale was used to determine the pain severity [18]. The validated Turkish version of the Oswestry Disability Index was used to define the limitations of the patients [19]. This index measures functional insufficiency during daily living activities such as personal care, walking, lifting, standing, sleeping, sitting, sex life, social life, and travel. The level of disability is calculated a total of 100 points. As the score of patients increases, the disability level also increases [19].

Biodex Balance SD (12.1'Display 115 VAC) device, whose validity, and reliability study were conducted by Sherafat et al., was used to evaluate postural control of the patients [20]. Limits of stability

(LOS) and clinical test of sensory interaction and balance (CTSIB) were performed. In both tests, the age, foot positions, and platform adjustments of the patients were recorded. Throughout the tests, the patients were asked not to get support from their hands and not to change the foot position. Each test was replicated 3 times.

In the limits of the stability test, the patients were asked to reach 8 different points on the fixed firm surface without changing their foot positions on the balance platform and to return to the starting position each time. This test was performed to determine the patient's ability to stay within stability limits for optimal postural control. The higher index values and the shorter time to complete the test indicate better dynamic postural control.

In the CTSIB, the patients were asked to stay in balance, primarily on a firm surface with eyes open and then closed, and then on a foam surface with eyes open and closed, respectively. Patients were warned not to change the foot position during each test for 30 seconds. This test was performed to obtain information about the patient's vestibular functions together with the proprioceptive system. Higher index values indicate a worse sensory interaction balance.

2.4. Statistical Analysis

Statistical analyzes were performed using the "SPSS (Statistical Package for the Social Sciences) 25.0 for Windows" program. Descriptive statistics of dependent and independent variables were shown with frequency and means, minimum and maximum values were specified. The compatibility of the variables to normal distribution was analyzed using the Shapiro-Wilk test. Pearson's correlation analysis was performed to determine the correlation between pain severity, disability level, and postural control. The significance level was set as $p<0.05$.

Considering the effect sizes, a power analysis was calculated with Open Source Epidemiologic Statistics for Public Health (Open Epi Version 3.1) program using the primary criteria, which was firm surface eyes closed sensory interaction balance. The power of the study was found to be 84.8% at a 95% confidence interval [21].

3. Results

A total of 122 patients who met the inclusion criteria were evaluated. However, since the disc problem was in the sequestration stage and the evaluation of these patients posed a health risk, 3 patients were excluded from the study, therefore the study was completed with 119 patients. It was observed that the patients included in the study were between the ages of 20 and 65, and 64 of them were female (53.79%) and 55 were male (46.21%). The demographic and clinical characteristics of the patients are given in Table 1.

Table 1. Demographic and clinical characteristics of patients

	X̄±SD	**Minimum-Maximum**
Age (years)	46.23 ± 14.83	20.0-65.0
BMI (kg/m^2)	28.08 ± 5.22	16.27-29.78
Disease duration (years)	6.02 ± 5.89	0.50 – 25.00
Pain (VAS)	6.31 ± 2.58	0.00 – 10.00
Oswestry Disability Index	31.79 ± 9.02	10.00 – 51.00
Limits of Stability (LOS) Indices		
Total LOS	45.86 ± 11.85	11.00 – 74.00
Forward	55.33 ± 17.58	9.00 – 93.00
Backward	55.11 ± 19.84	13.00 – 98.00
Left	56.10 ± 16.75	12.00 – 89.00
Right	54.82 ± 14.52	25.00 – 90.00
Forward-left	55.09 ± 15.48	17.00 – 86.00
Forward-right	58.38 ± 16.35	23.00 – 90.00
Backward-left	49.97 ± 16.30	5.00 – 86.00
Backward-right	46.69 ± 17.52	14.00 – 95.00
Clinical Test of Sensory Interaction and Balance (CTSIB) Indices		
EO-FiS	0.93 ± 0.58	0.15 – 2.70
EC-FiS	1.16 ± 0.64	0.31 – 3.47
EO-FoS	1.18 ± 0.78	0.34 – 4.46
EC-FoS	2.25 ± 0.95	0.94 – 6.35

BMI: Body Mass Index, LOS: Limits of Stability, CTSIB: Clinical Test of Sensory Interaction and Balance, EO: Eyes Open, FiS: Firm Surface, EC: Eyes Closed, FoS: Foam Surface

The relationship between pain severity, disability level, and postural control parameters was shown in Table 2. Sensory interaction balance was significantly correlated with pain and disability, and the relationship was weak and positive ($p < 0.05$). There was no significant correlation between LOS, pain, and disability ($p < 0.05$), (Table 2).

Table 2. Relationship between pain severity, disability score, and postural control parameters of patients

	Limits of Stability	**Clinical Test of Sensory Interaction and Balance**			
	Total value	EO-FiS	EC-FiS	EO-FoS	EC-FoS
Pain Severity (VAS)	r = -0.008 p = 0.945	r = 0.337** p = 0.002	r = 0.245* p = 0.023	r = 0.279* p = 0.009	r=0.286* p = 0.008
Oswestry Disability Index	r = -0.026 p = 0.809	r = 0.240* p = 0.026	r = 0.250* p = 0.026	r = 0.311* p = 0.004	r=0.350* p = 0.001

*****p<0.05, ******p<0.01 EO: Eyes Open, FiS: Firm Surface, EC: Eyes Closed, FoS: Foam Surface

4. Discussion

The findings of the study showed that, as pain and disability levels of patients increased, sensory interaction balance decreased in patients with LDH. It was also observed that the pain and disability level did not affect patients' limits of stability.

Pain is the most important symptom in lumbar disc herniation and is the primary reason for a consultation with a healthcare facility. There may be different reasons for the pain that occurs in lumbar disc problems. One and essential of these is nerve root compression [22]. Intervertebral disc problems cause unilateral lower extremity symptoms in most patients, and this causes asymmetric loading to

extremities and ground. Postural problems and muscle strength imbalance due to asymmetric loading are expressed as other causes of increasing widespread pain intensity [23].

It has been stated that postural control was negatively affected in patients with LDH when compared to the healthy group. The possible reasons for postural control impairment may be pain due to root compression, loss of strength, and decreased tendon reflexes [24]. In addition, balance and postural oscillation problems may occur due to pain severity in patients with low back pain [6,12]. Moseley et al. found that low back pain may increase postural oscillations [25], while Ruhe et al., showed a linear and positive relationship between pain intensity and postural oscillation [15]. Della Volpe et al., also showed that postural control can be impaired by chronic low back pain, and oscillations can be increased especially in dynamic conditions [26].

In our study, instead of examining the relationship with postural control by categorizing pain intensity as low or high pain, we questioned the instant pain when the patient came to the clinic. Unlike other studies, our results concluded that the pain was not related to the stability limits, but it negatively affected the sensory interaction balance. The reason why there was no correlation between pain and LOS may moderate pain levels of the patients, which did not cause a postural control problem in a way that would affect LOS. On the other hand, the reason why the pain was related to sensory interaction balance might be negatively affected vestibular inputs by pain together with proprioceptive impairment.

Brech et al. conducted a study with 10 patients with low back pain and examined if there was a relationship between pain intensity and sensory interaction balance. Their results showed there was no relationship between pain intensity and postural control [27]. Unlike this study, our results indicated that as the levels of disability increase, the sensory interaction balance decreases, but there was no relationship between disability level and LOS. We thought that body mass index may play a role in the emergence of this result. In other words, the decrease in sensory interaction balance of the patients due to disability whereas LOS might not have affected by it. This finding may indicate that increased body mass index can negatively affect some vestibular components more. So, these patients may have developed better adaptation to stability limits due to increased BMI.

In our study, the relationship between pain, disability, and postural control was examined in patients with LDH instead of those with chronic nonspecific or mechanical low back pain. In this context, the results of our study concluded that sensory interaction balance is negatively affected by pain in patients with LDH. In the light of these findings, approaches to increase postural control should not be ignored in evaluation and treatment approaches in patients with LDH.

The most important limitation of our study was the completion of the study with only patients whose herniation stages were bulging and protrusion, which are the initial levels of disease. Examining the relationship between pain, disability and postural control in patients who will be categorized according to different pain and disease stages might be guided in future studies. Since lower extremity muscle strength may affect postural control, evaluation of muscle strength in future studies may strengthen these studies in this respect.

The strengths of our study are 1) The multidimensional, dynamic, and objective evaluation of postural control with using LOS and sensory interaction balance parameters; 2) It is the first known study in the literature to investigate the relationship between pain, disability level, and postural control conducted with LDH patients.

5. Conclusion

Pain and disability can cause impairments in postural control in patients with LDH. Although there was no LOS influence in these patients, sensory interaction balance was negatively affected by an increased level of pain and disability. For this reason, approaches aiming to increase sensory interaction

balance as well as to reduce pain and disability should be adopted in assessment and treatment programs of patients with LDH.

Ethical Statement

Ethical approval for the research was obtained before commencement from the Non-Interventional Clinical Research Ethical Committee of the Dokuz Eylül University (date: 08.06.2017; decision number: 2017/15-20). A written informed consent form was signed by the participants based on the Declaration of Helsinki.

Conflict of Interest

All authors declare that they have no conflict of interest.

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Author Contributions

MST had a role in the conceptualization, data curation, formal analysis, methodology, project administration, supervision, validation, visualization, writing - original draft, writing - review & editing. ATY had a role in the conceptualization, data curation, formal analysis, methodology, visualization, writing - original draft, writing - review & editing. NG had a role in data curation; methodology, investigation, software, supervision, visualization, writing - original draft. OK had a role in methodology, administration, supervision, writing - review & editing. All authors read and approved the final manuscript.

References

[1] Peterka, R.J., "Sensorimotor integration in human postural control", *Journal of Neurophysiology*, 88(3), 1097-1118, 2002.

[2] Comber, L., Sosnoff, J.J., et al., "Postural control deficits in people with Multiple Sclerosis: A systematic review and meta-analysis", *Gait & Posture*, 61, 445-452, 2018.

[3] Jahn, K., Freiberger, E., et al., "Balance and mobility in geriatric patients: Assessment and treatment of neurological aspects", *Zeitschrift fur Gerontologie und Geriatrie*, 52(4), 316-323, 2019.

[4] Goossens, N., Rummens, S., et al., "Association between sensorimotor impairments and functional brain changes in patients with low back pain: a critical review", *American Journal of Physical Medicine & Rehabilitation*, 97(3), 200-211, 2018.

[5] Li, J., Zhang, Y., et al., "Dynamical analysis of standing balance control on sloped surfaces in ındividuals with lumbar disc herniation" *Scientific Reports*, 10(1), 1676, 2020.

[6] Sipko, T., Kuczyński, M., "Intensity of chronic pain modifies postural control in low back patients" *European Journal of Pain*, 17(4), 612-620, 2013.

[7] da Silva, R.A., Vieira, E.R., et al., "People with chronic low back pain have poorer balance than controls in challenging tasks", *Disability & Rehabilitation*, 40(11), 1294-1300, 2018.

[8] Caffaro, R.R., França, F.J., et al., "Postural control in individuals with and without non-specific chronic low back pain: a preliminary case-control study", *European Spine Journal*, 23(4), 807-813, 2014. Doi: 10.1007/s00586-014-3243-9.

[9] Ringheim, I., Austein, H., et al., "Postural strategy and trunk muscle activation during prolonged standing in chronic low back pain patients", *Gait & Posture*, 42(4), 584-589, 2015.

[10] Johanson, E., Brumagne, S., et al., "The effect of acute back muscle fatigue on postural control strategy in people with and without recurrent low back pain", *European Spine Journal*, 20(12), 2152-2159, 2011.

[11] Brumagne, S., Janssens, L., et al., "Altered postural control in anticipation of postural instability in persons with recurrent low back pain", *Gait & Posture*, 28(4), 657-662, 2008.

[12] Brumagne, S., Janssens, L., et al., "Persons with recurrent low back pain exhibit a rigid postural control strategy", *European Spine Journal*, 17(9), 1177-1184, 2008.

[13] Behennah, J., Conway, R., et al., "The relationship between balance performance, lumbar extension strength, trunk extension endurance, and pain in participants with chronic low back pain, and those without", *Clinical Biomechanics (Bristol, Avon)*, 53, 22-30, 2018.

[14] Emami, F., Yoosefinejad, et al., "Correlations between core muscle geometry, pain intensity, functional disability and postural balance in patients with nonspecific mechanical low back pain", *Medical Engineering & Physics*, 60, 39-46, 2018.

[15] Ruhe, A., Fejer, R., et al., "Is there a relationship between pain intensity and postural sway in patients with non-specific low back pain?", *BMC Musculoskeletal Disorders*, 12, 162, 2011.

[16] Rosker, Z.M., Rosker, J., et al., "Impairments of postural balance in surgically treated lumbar disc herniation patients", *Journal of Applied Biomechanics*, 21, 1-7, 2020.

[17] Bouche, K., Stevens, V., et al., "Comparison of postural control in unilateral stance between healthy controls and lumbar discectomy patients with and without pain", *European Spine Journal*, 15(4), 423-432, 2006.

[18] Carlsson, A.M., "Assessment of chronic pain. I. Aspects of the reliability and validity of the visual analogue scale", *Pain*, 16(1), 87-101, 1983.

[19] Yakut, E., Düger, T., et al., "Validation of the Turkish version of the Oswestry Disability Index for patients with low back pain", *Spine (Phila Pa 1976)*, 29(5), 581-585, 2004.

[20] Sherafat, S., Salavati, M., et al., "Intrasession and intersession reliability of postural control in participants with and without nonspecific low back pain using the Biodex Balance System*", Journal of Manipulative and Physiological Therapeutics*, 36(2), 111-118, 2013.

[21] Sullivan, K.M., Dean, A., et al., "OpenEpi: a web-based epidemiologic and statistical calculator for public health", *Public Health Reports*, 124(3), 471-474, 2009.

[22] Kawakami, M., Weinstein, J.N., Associated neurogenic and nonneurogenic pain mediators that probably are activated for nociceptive input, in: *Low back pain: a scientific and clinical overview*, (Ed. JN Weinstein, SL Gordon SL), American Academy of Orthopedic Surgeons, Rosemont, pp. 265-274, 1996.

[23] van Dieën, J.H., Reeves, N.P., et al., "Motor control changes in low back pain: divergence in presentations and mechanisms", *The Journal of Orthopaedic and Sports Physical Therapy*, 49(6), 370-379, 2019.

[24] Truszczyńska, A., Dobrzyńska, M., et al., "Assessment of postural stability in patients with lumbar spine chronic disc disease", *Acta of Bioengineering and Biomechanics*, 18(4), 71-77, 2016.

[25] Moseley, G.L., Hodges, P.W., "Are the changes in postural control associated with low back pain caused by pain interference?", *The Clinical Journal of Pain*, 21(4), 323-329, 2005.

[26] Della Volpe, R., Popa, T., et al., "Changes in the coordination of postural control during dynamic stance in chronic low back pain patients", *Gait & Posture*, 24(3), 349-355, 2006.

[27] Brech, G.C., Andrusaitis, S.F., et al., "Correlation of disability and pain with postural balance among women with chronic low back pain", *Clinics (Sao Paulo, Brazil)*, 67(8), 959-962, 2012.