The Effect of Chronic Pain Intensity on the Stability Limits in Patients With Low Back Pain

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Abstract

Objective: The purpose of this study was to evaluate if the intensity of recurrent chronic pain would modify postural performance in reaching the functional limits of stability (LOS) in chronic low back pain (CLBP) patients.

Methods: Three groups of subjects were investigated. Healthy persons comprised the asymptomatic group (n = 32) while CLBP patients (n = 36) were divided into 2 subgroups, according to the reported intensity of resting pain on a numerical rating scale: patients with low (LP) and high pain (HP) levels. The maximal displacement of the center of pressure (COP) indexing the LOS magnitude and the COP mean velocity indexing the performance in reaching LOS were calculated on a Kistler force plate during forward and backward voluntary body lean with eyes open (EO) or closed (EC).

Results: The forward LOS was lower in both the LP ($P < .01$) and HP ($P < .01$) subgroups than in the asymptomatic under EO and EC conditions, while no differences between the LP and HP groups were found. The backward LOS was lower in the HP group than in asymptomatic but only with EC ($P = .01$). Eye closure caused an increase in forward ($P = .02$) and backward ($P = .001$) COP velocity in the LP group and forward COP velocity in the asymptomatic ($P = .04$) only. With EC, the only intergroup difference was lower forward COP velocity in the HP than LP group ($P = .04$).

Conclusion: Subjects with CLBP had reduced forward LOS regardless the pain level. However, the higher level of pain was associated with slower execution of voluntary leaning tasks, with EC only. (J Manipulative Physiol Ther 2013;36:612-618)

Key Indexing Terms: *Balance; Postural Equilibrium; Posture; Range of Motion; Articular*

The functional limits of stability (LOS) are defined as the area which is much smaller than the base of support and over which individuals can move their center of mass and maintain equilibrium without adjusting their base of support.[1] The center of pressure (COP) as the center of distribution of the total force applied to the base of support regulates the position a passive variable—the center of mass.[2]

Few studies have analyzed dynamic balance in chronic low back pain (CLBP) patients by assessing the limits of postural stability.[3-6] There is evidence based on an experiment with a movable platform that the alteration of neuromuscular control found in patients with CLBP may contribute to their LOS, making these patients more at risk for loss of equilibrium.[4] However, falling is not the largest problem related to decreased balance in individuals with CLBP, but a modified postural strategy which might sustain chronic symptoms and alter active daily living. Stiff postural strategy in automatic postural responses was especially evidenced in the postural tasks of CLBP patients,[6,7] as well as decreased voluntary forward lean[5] and even loss of variability in strategy selection.[8] CLBP patients reduced hip control strategy during quiet standing,[9] favoring the ankle strategy,[4,10] which was not effective in demanding conditions.[3,5]

Most of the studies[3,4,6,7] investigated automatic postural responses in dynamic balance of CLBP, but only Mientjes and Frank[5] estimated LOS in voluntary body lean, and only in the forward direction. All of these studies[3-7] excluded CLBP patients with increased pain; however, a characteristic CLBP symptom is recurrent pain with differing locations and intensity. It is known that in CLBP patients standing quietly, velocity of COP increased linearly with an increase in perceived pain intensity greater than 4 on a numerical pain scale,[11] but there is no explanation as to the effect intensity of recurrent chronic pain on dynamic balance.

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The aim of this study was to examine the forward and backward limits of stability during voluntary body lean, and the COP velocity as a measure of reaching LOS in subjects with low pain levels (LP) and with high pain levels (HP).

The purpose of this study was to evaluate if the intensity of chronic pain for CLBP patients would modify the postural performance in the voluntary LOS tasks. We hypothesized that pain intensity would modify performance in the following ways: (1) decrease the LOS magnitude and (2) decrease the velocity of task execution. It was expected that disturbances in the postural performance of the HP group were more likely to occur when the subjects' eyes were closed because of deficits in the sensorimotor processing associated with the pain level.

Methods

Subjects

Thirty-six people with CLBP aged 30 to 65 years, undergoing a non-invasive treatment in Cieplice Zdrój health resort participated in the study (for details see Ref.[12]). Thirty-two healthy persons served as an asymptomatic group. All participants were screened by physiotherapist and provided completed pain and status health questionnaire packages. The inclusion criteria encompassed patients with low back pain due to a herniated disc confirmed by magnetic resonance imaging who have had persistent or recurrent chronic pain for at least 3 months. The exclusion criteria included the presence of neurological diseases, orthopedic conditions, stenosis of the spinal canal, and surgical treatment of the herniated disc. The level of resting pain on the day of investigation was determined on the basis of a numerical rating scale of 0 to 10 (NRS) by marking the current intensity of pain.[13] The CLBP group was stratified in terms of pain intensity into a subgroup with low pain level (LP group; NRS = 0-3) and a subgroup with high pain level (HP group; NRS = 4-10). A cut-off point was found in the results of Corbeil et al,[14] as weak pain intensity minimally affected control of posture but the moderate and extreme pain intensities gradually deteriorated the postural system.

A convenience sample of 32 asymptomatic volunteers, who were not involved in any regular physical activity, was recruited from the Faculty of Physiotherapy. The inclusion criteria encompassed asymptomatic subjects (NRS = 0), with no history of CLBP, aged 30–65. The exclusion criteria were as follows: neurological diseases, orthopedic problems of spine, hip, knee or foot, low back pain at the time of testing, and bad physical and mental state on the day of the study.

All subjects gave informed consent prior to their participation in the study, and the procedures were approved by the Academy of Physical Education Bioethics Committee.

Postural Balance Examination

The limits of stability were assessed according to a simplified protocol based on the traditional evaluation of LOS.[1] Subjects performed two 20-second trials on a hard surface, separated by 1-minute breaks. They performed the first trial with their eyes open (EO) and the second with their eyes closed (EC). The subjects were instructed to stand barefoot on a Kistler force plate (type 9286; http://www.kistler.com), with their feet parallel and 5 cm apart, and their gaze focused on a marker placed at eye level at a distance of 1.5 m. A practice trial was allowed prior to the test to ensure that the subjects were able to complete the task. They were asked to maintain full contact between the soles of their feet and the force plate during a voluntary body leaning.

The maximal displacement of the center of pressure (COP) was calculated duringa forward, followed by a backward, voluntary body lean, with EO or EC, relative to the baseline data computed as an average COP value from the first five seconds of standing in the resting position. The sampling rate was 100 Hz and the sampling time was 20 seconds, resulting in 2000 sampling segments for each recorded COP time series in the sagittal plane. The dependent variables included forward (LOS.For) and backward (LOS.Back) limits of stability in the sagittal plane and the mean velocity of the COP as a measure of reaching LOS in forward (LOS.VS.for) and backward directions (LOS.VS.back). For the between-subjects comparison, the COP data were normalized according to the subjects' foot lengths: normalized LOS = (LOS/foot length) × 100.[4,5]

Statistical Methods

Biometric data were compared statistically using one-way analysis of variance, followed by the Tukey post hoc test. As the postural measures had non-normal distribution, the results were presented as medians, mean, and SD. The statistical significance of the differences between groups was assessed with the Mann-Whitney U test. For the intra-group comparisons, to evaluate the effect of vision, a Wilcoxon matched pair test was applied. Spearman rank correlation was used to evaluate the relationships between LOS parameters and intensity of pain. The level of significance was set at $P < .05$. The effect size measure of Cohen's d was obtained and used to quantify the differences in outcome variables.

Results

Demographic Data

Both subgroups were alike in terms of age and height except for body weight and pain intensity. Asymptomatic group had significantly lesser weight than LP group ($P = .0004$) and lesser body mass index (BMI) than both subgroups ($P < .05$). The