Postural Stability Change in Young People with Low Back Pain

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Purpose: We investigated balance change in patients with low back pain (LBP) by comparing postural sway velocity between young LBP patients and healthy subjects.

Methods: The cross-sectional study enrolled 37 young patients with over 3-month duration of LBP and 38 healthy subjects between the ages of 20 and 30 years old. All subjects were targeted by measuring their balance during quiet standing with open eye and closed eye conditions. The postural sway velocity between the LBP patients and healthy subjects was compared. As well, postural sway velocity was determined in the LBP patients with both eyes open and closed.

Results: Significant differences were evident in the anteroposterior and mediolateral mean velocity of center-of-pressure between LBP patients and healthy subjects, and in LBP patients in the eye open and eye closed conditions.

Conclusion: The balance of young LBP patients was worse than healthy subjects during quiet standing, and was especially lessened in the absence of vision.

Keywords: Low back pain, Postural stability, Balance

I. Introduction

Low back pain (LBP) affects 22~26% of people annually.1 Usually the pain resolves within 6 weeks without any special medical intervention.2 However, in about 20% of cases, the pain develops chronic, which can lead to costly medical expenses and which drives the high prevalence rate.3 LBP may alter balance; when chronic, it can diminish posture control.4,5 Controlling and maintaining balance in the static and dynamic condition is a necessity for everyday physical activities.6 These controls require the coordinated efforts of body systems under control of the central nervous system (CNS).7 CNS-controlled muscle activity is required in the relationship between the center of mass and surface area.8

The CNS controls the postural stability in the standing position and when in motion, using the afferent information from visual, proprioceptive, cutaneous, and vestibular systems. Put another way, postural stability is based on vision, somatosensory, and vestibular influences, representing a united sensitive information input.9 This input facilitates continuous judgment of movement and posture control in three-dimensional space, and is the basis of the appropriate strength needed to maintain and adjust balance.9 A deficiency in any of these senses will lessen the control of posture.

Posture stability is normally explained with the change in center-of-pressure (COP) and excursion.8 COP refers to the pressure concentrated on one point of the sole of the feet.10 So, the sway of the body can be judged by measuring the change in the COP on the force plate.10 Body sway in humans involves neuromotor factors and control reflective reaction and posture.6,11 The efficiency of the balance system decreases due to age and because of neurologic or musculoskeletal diseases that decrease the ability of sense and movement. LBP affects the ability of control posture.12,13 Non-specific LBP can result in an imbalance in the pelvic complex, and decreases
agility and coordination.\textsuperscript{14,15} Decreased muscle strength of the pelvic complex and the trunk can destabilize the hip joint\textsuperscript{16} and negatively affect the proprioceptive sense.\textsuperscript{12} LBP patients increase their dependence on visual information.\textsuperscript{12}

LBP has been shown to detrimentally affect balance in older people (65~70 years of age)\textsuperscript{9} and chronic LBP patients display more exacerbated problems compared with those who do not have LBP.\textsuperscript{17} The strategy of hip joint use decreases due to LBP,\textsuperscript{18} and patients with chronic LBP decrease in their control over their standing posture.\textsuperscript{19}

Age could also be a contributor to decreased posture control, as a consequence of age-related degenerative changes of the neuromuscular system.\textsuperscript{4} But there are few studies investigating in young or old LBP subjects only. Thus, this study investigated the effects of LBP targeting young people.

II. Materials and Methods

1. Subjects

This study was done by 37 young patients with LBP, and 38 healthy people between the ages of 20 and 30 years old. Among the LBP patients, we selected those who have suffered pain on both sides of the lower back for more than 3 months. Healthy people had never had low back surgery, and had no history of abnormality in the spine or neuromuscular deficit. Participants provided written consent after the purpose of the study was clearly explained to them. The characteristics of the participants in this study are summarized in Table 1.

2. Procedures

The study had a cross-sectional design. Patients with LBP and healthy people were targeted by measuring their balance as postural sway velocity (PSV) during quiet standing with open eye and closed eye conditions. The PSV values were compared with those similarly determined for the healthy subjects. Also, PSV was determined in the LBP patients when they had their eyes open and closed.

3. Measurement

1) Pain

The degree of pain was rated by means of a visual analog scale.\textsuperscript{20} In the 0~10 scale, 0 represented 'no pain' and 10 represented 'unbearable pain'. After letting the patient mark the level of pain experienced, the researcher measured the distance from the starting point and converted it into a score.

2) Balance

PSV during quiet standing was measured using the Good Balance force platform (Metitur Ltd., Jyvaskyla, Finland). The force platform is an equilateral triangle that is connected to a three-channel amplifier. Signals from the amplifier are converted into a digital form using a 12-byte converter and stored on the hard disk of a personal computer. The reliability of the force platform measurements was assessed and the intraclass correlation coefficient for anteroposterior velocity varied from 0.51 to 0.74 and for mediolateral velocity from 0.63 to 0.83.\textsuperscript{21} The sampling rate was set at 50 Hz, and 12 Hz low-pass filtering was performed. The values of the variables including the anteroposterior and mediolateral sway velocity, velocity moment of COP were estimated. The mean velocity of the X and Y movements of the COP is achieved by dividing the extent of the X and Y movements by time (in seconds). To measure balance, the subject stood on the footprints marked symmetrically in relation to the midline of the force platform with the arms placed comfortably. PSV was measured with

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<th>Table 1. Subject characteristics</th>
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<td>Group (n=75)</td>
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<tr>
<td>Healthy people (n=38)</td>
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<td>LBP patients (n=37)</td>
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Values are number or mean±standard deviation.
LBP: low back pain, VAS: visual analog scale.
the eyes opened and closed randomly. In the open eye condition, the subject would stare at a point marked 1 meter in front of them. The measurements were done three times in each trial with a 30-s interval.\textsuperscript{22}

4. **Statistical analysis**

We used the independent t-test to compare differences on COP mean velocity between LBP patients and healthy subjects. And the paired t-test was used to compare differences on COP mean velocity between eye open and eye close condition in LBP patients and healthy subjects. All statistical procedures were conducted using the SPSS ver. 11.5 for Windows (SPSS Inc., Chicago, IL, USA). The statistical significant level was set at $p<0.05$ for all data.

III. Results

There were significant differences in the anteroposterior and mediolateral mean velocity, velocity moment of COP between LBP patients and healthy subjects in the eye open and eye closed condition ($p<0.05$) (Table 2). Significant differences in the anteroposterior and mediolateral mean velocity, and velocity moment of COP were also evident between the eye open condition and eye close condition in healthy people ($p<0.05$) and in the eye open condition and eye close condition in LBP patients ($p<0.05$) (Table 2).

IV. Discussion

In the results of present study was that healthy people exhibited 5.44 mm/s in PSV of the anteroposterior direction during quiet standing with eye open, 2.83 mm/s in the mediolateral, and 8.40 mm$^2$/s in the velocity moment. And in the eye close, PSV were recorded 6.67 mm/s in the anteroposterior, 3.49 mm/s in the mediolateral, and 10.70 mm$^2$/s in the velocity moment. The values were similar with that in the previous study.\textsuperscript{21} Also, LBP patients exhibited 7.13 mm/s in the anteroposterior and 4.04 mm/s in the mediolateral during quiet standing with eye open. And in the eye close, PSV were recorded 9.89 mm/s in the anteroposterior and 6.65 mm/s in the mediolateral.

LBP patients whose pain was non-specific experienced a greater change of balance than healthy people. The results are consistent with other results that LBP affects balance.\textsuperscript{6,17,23} Balance is a process of receiving sensory information from the vision, vestibular, and somatosensory systems.\textsuperscript{6} If any of these factors is blunted, the information will not be routed properly, which can increase instability and the risk of falling.\textsuperscript{24} LBP can change the sensory status for postural control.\textsuperscript{25} When the sensory system of the lumbar spine and trunk are chronically harmed, the conduction of sensory information such as proprioception decreases, which can substantially decrease the integrated sensory accuracy.\textsuperscript{7} Also, due to LBP, presynaptic inhibition of afferent information from muscles increases and feedback to muscle spindles decrease.\textsuperscript{26} As a result, posture sway increases. In the current study, young people with lower degenerative change displayed decreases similar to those previously detailed. This result shows that the change in neuromuscular system or presynaptic inhibition is due to the length of time of LBP-mediated compromise.

We also found significant difference between PSV in the eye open and eye closed conditions. Blocking vision

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<th>Healthy people (n=38)</th>
<th>LBP patient (n=37)</th>
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<tr>
<td></td>
<td>Eye open</td>
<td>Eye close</td>
</tr>
<tr>
<td>Anteroposterior sway velocity (mm/s)</td>
<td>5.44±1.53</td>
<td>6.67±1.43*</td>
</tr>
<tr>
<td>Mediolateral sway velocity (mm/s)</td>
<td>2.83±1.75</td>
<td>3.49±1.15*</td>
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<tr>
<td>Velocity moment (mm$^2$/s)</td>
<td>8.40±4.50</td>
<td>10.70±4.08*</td>
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Values are mean±standard deviation.
LBP: low back pain.
* $p<0.05$ by paired t-test, † $p<0.05$ and ‡ $p<0.01$ by independent t-test.
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substantially affected balance. These results corroborate those of prior studies, in which lack of vision affected problem solving and balance.\textsuperscript{7,17} The collective results support the view that dependence on the vision increases control balance by the change of proprioceptive sense. Vision is the primary sense that controls the sway of low amplitude.\textsuperscript{17} Also, integration with information from the vestibular system is essential to maintain an upright posture.\textsuperscript{10} Like the non-specific LBP patients whose proprioceptive senses are low, vision is important in the control of balance. So, as evident presently, balance is greatly affected in LBP patients. It is the one of the factors that increases the response time of spine muscles for stimuli resulting from pain-related change in proprioceptive senses.

And in this study, I did not find greater differences in mediolateral PSV between the LBP patients and healthy people compared to anteroposterior sway velocity. In the previous studies, they reported that using the strategies of hip joint may limit due to decrease the flexibility and power of the region of low back and pelvis in the LBP patients.\textsuperscript{16} But, although the subjects were participated in this study had the chronic pain for more than three months, they were young relatively and the pain did not last long. So there were no greater differences in the mediolateral PSV compared to anteroposterior due to they did not limit using the strategies of the hip joint for maintain the balance.

The present results have not clarified whether decreased balance related to LBP is the result of proprioceptive sense or of a suppressed synaptic transfer. Further studies are needed to precisely identify the reason for the LBP-mediated decrease in balance.

This was a study done targeting young people with LBP who don’t get affected a lot with the degeneration on age, and compared the change in balance with the healthy people. As a result, the balance decreases with pain while the patients are standing, and more decrease in balance is shown when the vision are blocked. From the current study, we found that LBP brings decrease in balance, specially change in proprioceptive sense. However, additional study will be needed since we couldn’t find the clear factor that affects the matter of balance.

Author Contributions

Research design: Lee GC
Acquisition of data: Lee GC
Analysis and interpretation of data: Lee GC
Drafting of the manuscript: Lee GC
Research supervision: Lee GC

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References