



Original Article

## Effects of gyrokinesis exercise on the gait pattern of female patients with chronic low back pain

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**Abstract.** [Purpose] The purpose of the present study was to use kinematic variables to identify the effects of 8/ weeks' performance of a gyrokinesis exercise on the gait pattern of females with chronic low back pain. [Subjects] The subjects of the present study were females in their late 20s to mid 30s who were chronic back pain patients. [Methods] A 3-D motion analysis system was used to measure the changes in their gait patterns between pre and post-gyrokinesis exercise. The SPSS 21.0 statistics program was used to perform the paired t-test, to compare the gait patterns of pre-post-gyrokinesis exercise. [Results] In the gait analysis, pre-post-gyrokinesis exercise gait patterns showed statistically significant differences in right and left step length, stride length, right-left step widths, and stride speed. [Conclusion] Gait pattern analysis revealed increases in step length, stride length, and stride speed along with a decrease in step width after 8 weeks of gyrokinesis exercise, demonstrating it improved gait pattern.

**Key words:** Gyrokinesis exercise, Chronic low back pain, Gait analysis

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### INTRODUCTION

Lower back pain is one of the most commonly presented musculoskeletal diseases in modern society<sup>1)</sup>, and about 70–85% of the population is estimated to have experienced lower back pain<sup>2)</sup>.

There are several causes of lower back pain, but the most common is nonspecific cause due to epidemiological factors and degenerative changes in the lower back structure and the surrounding tissues, and it accounts for 85% of all cases<sup>3)</sup>. The symptoms of lower back pain include paresthesia, radiating pain in the lower limbs, pain during rest or exercise, decline in muscle strength and joint range of motion, and bilateral asymmetry of the lower limbs. This can lead to problems with sense of joint location and motion, sense of weight, and perceived timing of muscle contraction<sup>4)</sup>, which can further result in damage to the proprioceptive senses<sup>5)</sup>.

As a pathological mechanism, chronic lower back pain can lead to weakening of muscles near the spine, damage to trunk soft tissues, decrease in trunk muscle endurance, and degenerative changes in the intervertebral disc, which eventually cause instability of the spine<sup>6)</sup>. Persistent lower back pain can cause abnormality in the movement patterns of the pelvis, spine, and lower limbs<sup>7)</sup>. Moreover, an asymmetric gait pattern can result from pain and paresthesia<sup>8)</sup>, and decreased gait speed in patients with chronic lower back pain is known to be caused by pain and pain-related fear avoidance behavior, as well as the effort to reduce pain by restricting spinal movement<sup>9, 10)</sup>.

Gait is a complex process that involves the nervous and musculoskeletal systems. It is the repetitive and continuous motion which moves the body forward while maintaining a stable state during the stance phase<sup>11)</sup>, and the physical activities of upright gait connect the lower limb joints and the spine, the central pillar of the trunk, in a kinetic chain, mutually influencing each other<sup>12)</sup>. The role of the spine is essential in normal gait and spinal deformation affects the normal gait pattern<sup>13)</sup>, which provides important information for the treatment of patients with walking problem through gait pattern analysis<sup>14)</sup>.

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Spinal misalignment and musculoskeletal problems are related to gait pattern<sup>15</sup>, and they have an effect on the elements of gait pattern, such as stride length, step length, step width, and gait speed<sup>16</sup>.

Gait analysis provides basic scientific data for understanding the pathological gait mechanism through objective and quantitative assessment, and approaches for gait analysis include observational gait analysis, automated 3-D gait analysis, as well as analysis methods using force plate data<sup>17</sup>.

Transient lower back pain can be improved mostly by rest, physical therapy, and medication, but it can become chronic for various reasons. Lower back pain can become chronic while being treated in the acute and subacute stages. For treatment of lower back pain, drug and pain therapies can be effective at alleviating pain in the acute and subacute stages, but in the case of chronic lower back pain, exercises designed to strengthen muscles and ligaments are primarily used, since drugs and physical therapy can only provide temporary pain relief and cannot resolve the fundamental causes<sup>18,19</sup>. Exercises for lower back pain relief include pelvic tilt, muscle strengthening, flexibility enhancing, endurance enhancing and physical function enhancing exercises, and they are highly effective for truncal stabilization in lower back pain patients<sup>20</sup>. Moreover, since lower back pain patients have weak lumbar extensor strength, it is ideal to actively engage in lumbar extensor strengthening exercises focused on the erector spinae muscle.

Among lumbar extensor strengthening exercises, the gyrotonic system has recently drawn attention as an exercise program focused on the spine, and it is derived from exercises in a variety of fields, such as yoga, Pilates, tai chi, gymnastics, and swimming. This system involves exercise that uses equipment that was specially designed in 1982 by Juliu Horvath, a former gymnast and senior dancer in the Romanian National Ballet. Gyrotonic exercise helps to improve muscle strength and flexibility by promoting enhancement of circular and spiral movements that start at the spine and extend to each part of the body. Moreover, this system is also an effective exercise for developing a balanced bone structure and body shape through facilitation of muscle contraction and relaxation. For this reason, it has received much attention in the US and Europe. However, studies that have provided objective evidence of its effects are lacking.

Therefore, gyrotonic exercise that uses a mat and stool was performed for 8 weeks in the present study to investigate effects this exercise has on the gait pattern of females with chronic lower back pain.

## SUBJECTS AND METHODS

The subjects in the present study were females in their late 20s to mid 30s who were diagnosed as having chronic back pain that had persisted for more than 3 months, based on CT and MRI findings, by a specialist at the spine center in “B” Hospital located in “B” city of South Korea. The mean age, height, and weight of the subjects were 29.50±2.53 years, 163.45±2.53 cm, and 55.57±10.09 kg, respectively. The subjects read and signed an informed consent form approved by the Inje University Ethics Committee for Human Investigations prior to their participation.

Among the gyrotonic exercises, a gyrotonic exercise that uses a mat and stool was employed. Awakening of the sense was performed first by stimulating the senses by bodily and self-contact, which was followed by 50 min of exercise that was divided into movements on the stool and mat centered on spinal motion involving front/back/left/right flexion and extension of the spine, lateral flexion, and aerobic exercise with movement to support the pelvis and spine through the strength of the lower limbs. Cool-down was performed by static stretching. For the gyrotonic exercise intensity, the Rating of Perceived Exertion Scale (RPE) developed by Borg (1983) was used to set the level to RPE 9–13 (very light–somewhat hard) for warm-up and cool down and RPE 13–15 (somewhat hard–hard) for the main exercise<sup>21</sup>. The frequency and duration of exercise consisted of 70 minutes per session, 2 sessions per week, for 8 weeks.

A 3-D motion analysis system was used to measure the changes in gait patterns between pre- and post-gyrotonic exercise, and gait testing was conducted in 5 iterations separated by 1 minute intervals on a 15-m walkway, to enable the subjects to safely complete their gait test. During gait, data from completion of the first stride (1st stride) and stride length from the moment the right foot touched down (2nd stride) were collected, and the motion of 3 out of 5 iterations that were most similar to normal walking were analyzed. The SPSS 21.0 statistics program was used to perform the paired t-test, to compare the differences in the gait patterns of pre- and post-gyrotonic exercise, and the amount of change between pre- and post-gyrotonic exercise was calculated as %diff. A statistical significance level of  $\alpha=0.05$  was used.

For collection of gait pattern data, the present study used a motion analysis system comprising 6 infrared cameras, which captured gait motion at 100 Hz. Data were filtered using a Butterworth low-pass filter with a cut-off frequency of 6 Hz. The Vicon Nexus 1.7 program was used to analyze the kinematic data.

## RESULTS

The comparative analysis results of pre- and post-gyrotonic exercise right and left step length, stride length, right and left step width, and stride speed are shown in (Table 1).

Gait analysis, comparisons of values of pre- and post-gyrotonic exercise showed statistically significant differences in all parameter: right step length (61.33±6.98 vs. 69.79±6.37,  $p<0.001$ ), left step length (59.79±5.90 vs. 67.79±6.37,  $p<0.001$ ), stride length (121.94±12.64 vs. 138.40±11.81,  $p<0.001$ ), right step width (6.56±2.03 vs. 3.37±1.57,  $p<0.001$ ), left step width (8.08±1.60 vs. 5.47±2.11,  $p<0.001$ ), and stride speed (1.13±0.32 vs. 1.44±0.19,  $p<0.001$ ).

**Table 1.** Pre- and post-gyrokinetic exercise step length, stride length, step width, and stride speed

		pre	post	t-value	%diff
Length (cm)	R step	61.33±6.98	69.79±6.37	-5.883***	14.61
	L step	59.79±5.90	67.79±6.37	-5.855***	13.92
	stride	121.94±12.64	138.40±11.81	-5.947***	14.23
Width (cm)	R step	6.56±2.03	3.37±1.57	5.682***	-43.31
	L step	8.08±1.60	5.47±2.11	5.461***	-32.02
Speed (m/s)	stride	1.13±0.32	1.44±0.19	-4.786***	21.84

\*\*\*p<0.001

R step: From right heel strike to left heel strike, L step: From left heel strike to right heel strike, stride: From right heel strike to same right heel strike

## DISCUSSION

Feet with lesions and normal feet are known to show an asymmetric gait pattern. previous studies have reported that the typical gait pattern of patients with chronic lower back pain shows asymmetric gait, evidenced by decreased step length and step speed, along with widened step width, due to pain, pain-related fear avoidance behavior, and effort to reduce pain by restricting spinal movement<sup>22</sup>). The present study showed there were changes in step length, stride length, step width, and stride speed in the gait pattern analysis results following 8 weeks of gyrokinesis exercise, indicating that gyrokinesis exercise does have an effect on the gait pattern of chronic lower back pain patients. After the completion of the gyrokinesis exercise regimen, the chronic lower back pain patients showed increases in right step length, left step length, stride length, and stride speed of approximately 14.61, 13.92, 14.23, and 21.84%*diff*, respectively, as well as decreases in right and left step width of approximately -43.31 and -32.02%*diff*, respectively. these were different from the typical gait pattern, and based on these results, it was determined that gyrokinesis exercise improved the in gait pattern.

Additional future studies of gyrokinesis exercise are needed, not only of pattern gait, but also of various kinetic variables, involving larger numbers of subjects and long-term training, focusing on the characteristic of gyrokinesis exercise as an exercise method for the spine.

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