J Int Acad Phys Ther Res 2018; 9(3): 1543~1548
ISSN 2092-8475
www.iaptr.org
https://doi.org/10.20540/JIAPTR.2018.9.3.1543

The Effects of Manual Therapy on Lower Extremity Alignment in Pelvic Malalignment

The purpose of this study was to analyze the effects of manual therapy on lower extremity alignment in pelvic malalignment. The subjects were 20 adults with pelvic malalignment. They were divided into two groups: manual therapy group (n=10) and stretching exercise group (n=10). Each group performed the intervention two times per week for 4 weeks. The lower extremity alignment was measured by pelvic deviation, functional leg length inequality, and plantar pressure distribution, which were measured between pre- and post-test. In the result of pelvic deviation, there was a significant difference between the pre- and post-test of the manual therapy group and stretching exercise group. In the result of the functional leg length inequality, there was a significant difference between the pre- and post- test of the manual therapy group. In the result of plantar pressure distribution, there was a significant difference between the pre- and post- test of the manual therapy group. These findings suggest manual therapy improves the pelvic deviation, functional leg length inequality, and plantar pressure distribution in the pelvic malalignment.

Key words: *Manual Therapy, Lower Extremity Alignment, Pelvic Malalignment*

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Received : 15 May 2018
Revised : 27 June 2018
Accepted : 02 July 2018

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INTRODUCTION

Pelvis is a structure that can bear the load of all the body weight except the lower extremity. Sacroiliac joint is the bridge between the lower end of the trunk skeleton and the lower extremity skeleton. The tightly connected sacroiliac joint is primarily structured for stability and acts to efficiently deliver large loads between the vertebrae, the lower extremity, and the ground. Pelvic deviation can be caused by continuous and repetitive one-direction torsion of the pelvis by bad postural habit. The stress by abnormal posture caused impairment of the joints as there were malalignment of ilium, asymmetry of the pelvis by leg length inequality, hyper lordosis, and scoliosis [1]. The bad postural habit caused the malalignment of the spine and the pelvis, which collapses the balance of the body. This results in kinematic changes as the asymmetric displacement of the skeleton and range of movement of the muscles and the joints, which cause problems accompanied by dysfunction of the joints and pain. Basic pelvis deviation is governed by the movement of the hip joint. When the ilium is posterior malalignment, the nutation in sacrum caused by auricular surface that is the joint surface between the ischium and sacrum and does not cause pure posterior malalignment but the posteroinferior malposition includes inferior malalignment. When the ischium is anterior malalignment, the counter-nutation in sacrum, the anterosuperior malposition includes superior malalignment. These changes account for 80% to 85% of the total pelvic malalignment. In addition, there can appear not only rotation malalignment as outflare and inflare, which are movements in the transverse plane in relation to the vertical axis, but also upslip and downslip where the pelvis is purely moved [2].

There is a correlative relation between the pelvic malalignment and the functional leg length inequality. The functional leg length inequality is caused by a torsion of the pelvis, knee joints, lower extremities, and ankle joints in the case that a posture is wrong. The lower extremities articulate the acetabulum of the innominate bone, so that the functional leg length inequality can be easily observed according to the pelvic deviation. The posteroinferior malposition of the pelvis acts to lift the hip joint upward and forms the functional short leg while the anterosuperior malalignment forms the functional long leg [3, 4]. In addition, the foot provides the driving force and the direction necessary for the movement of the trunk during walking, absorbs the physical impact at this time, supports the weight, adapts to the ground, and maintains balance by response to the movement of the center of the body's gravity. Thus, the functional leg length inequality affects plantar pressure by causing the change of the ground reaction force [5]. The functional leg length inequality affects the muscular system related to walking and increases tension that occurs at the place where the pressure, tension, and muscle contact the joint [3]. The pelvic tilting may also appear in the functional leg length inequality of less than 10mm, which secondarily may be accompanied by functional scoliosis and hip. The functional leg length inequality of more than 10mm especially causes increasing significant change of the posture and affects various physical activities such as standing posture, balance, and gait function [6].

The manual therapy is about three times more satisfying than general medical treatment [7]. A previous study reported Cobb's angle was decreased by applying the manual therapy for four weeks in an elementary school student [8]. Another previous study reported the results of manual therapy which was applied to 102 ambulatory patients with acute back pain and sciatica with disc protrusion manual therapy. The active manual therapy had more effect on the pain relief than simulated manipulation [9].

Most of the previous studies considered that the manual therapy was applied on spinal diseases such as scoliosis and kyphosis, and the changes were related to spinal alignment and pain. Therefore, this study examined to the effects of manual therapy on the pelvic deviation, the functional leg length inequality, and the plantar pressure distribution, analyzing the lower extremity alignment in pelvic malalignment.

SUBJECTS AND METHODS

Subjects

The subjects of this study were 20 adults with pelvic malalignment in their 20s at N university in Cheonan, Republic of Korea (Table 1). They were verified as having pelvic malalignment by Functional 3D Spine & Posture Analysis (DIERS Formetric 4D, DIERS International GmbH, Germany). The exclusion criteria included musculoskeletal or neurological disease. They were provided explanation for the experiment then they agreed and voluntarily participated in this study. They also provided informed consent prior to their participation.

Experimental Equipment

A Body Composition Analyzers (Inbody 720, Biospace, Seoul, Republic of Korea) were used to measure the general characteristics of the subjects. A Functional 3D Spine & Posture Analysis was used to measure the pelvic deviation and spinal alignment. A Static and Dynamic Foot Pressure Measurement (Pedoscan, DIERS International GmbH, Germany) was used in plantar pressure.

Measurement

Each subject measured the pelvic deviation, functional leg length inequality, and plantar pressure. The pelvic deviation was measured as tilt, torsion, and rotation of pelvis in standing position by analyzing the contours which were all made of vertebral segments and the surface of the pelvis [10]. The functional leg length inequality was measured by tape measure method, which is considered to be of no significant

Table 1. Characteristics of subjects (N=20)

Characteristics	Manual therapy	Stretching exercise	p
Sex(male/female)	3/7	4/6	.639
Age (yrs.)	21.800±2.394	20.800±1.874	.589
Height (cm)	166.640±10.158	165.210±10.293	.905
Weight (kg)	63.960±9.472	57.070±7.475	.274
BMI (kg/m²)	22.970±2.163	20.860±1.557	.274

Values are showed Mean ± SD

difference compared with the radiological finding. The distance between the anterior superior iliac spine and the most protruding part of the medial malleolus in supine position. The mean of three measured data was used as the data in order to increase reliability. The plantar pressure was measured as the pressure distribution. The instability of the plantar pressure of both feet was compared through the difference of percentage of both plantar pressures [3, 6, 11].

Procedure

The subjects were divided into two groups: manual group and stretching exercise group. The manual group performed manual therapy using diversified technique according to the pelvic alignment of each subject. The manual therapy was composed of posteroinferior deviation, anterosuperior deviation, inferior deviation, superior deviation, inferior deviation, and superior deviation in side-lying position. The posteroinferior deviation manipulation was applied by fixing a shoulder by the upper hand and forcing a posterior superior iliac supine in the anterosuperior direction by lower hand. The anterosuperior deviation manipulation was applied by fixing a shoulder by the upper hand and forcing ischial tuberosity in the anterosuperior direction by the lower hand, the ischial tuberosity revealed by lifting both the knees of the subject. The inferior deviation direction was applied by fixing and pulling a shoulder downward by the upper hand and forcing an ischial tuberosity by the lower hand. The superior deviation direction was applied by fixing the upper arm by the upper hand and forcing a popliteal fossa by lower hand downward. They performed a warm-up exercise and cool-down exercise for 2 minutes and manual therapy for 6 minutes and a total of 10 minutes, two times per week for 4 weeks (Table 2).

The stretching exercise group performed stretching exercise on pelvic and lower extremity muscles: iliopsoas, gluteal muscles, quadriceps, hamstrings, hip abductors, hip adductors, and calf muscles. They performed warm-up exercise and cool-down exercise for 2 minutes and stretching exercise for 6 minutes—for a total of 10 minutes, two times per week for 4 weeks (Table 3).

Table 2. Manual therapy program(Chiropractic manipulation)

Exercise	Contents	Frequency	Time
Warm-up	Cervical and trunk stretching	15 sec 2 times	2 min
Main	Chiropractic manipulation Posteroinferior deviation Anterosuperior deviation Inferior deviation Superior deviation		6 min
Cool-down	Cervical and trunk stretching	15 sec 2 times	2 min

Table 3. Stretching exercise program

Exercise	Contents	Frequency	Time
Warm-up	Cervical and trunk stretching	15 sec 2 times	2 min
Main	Iliopsoas Gluteal muscles Quadriceps Hamstrings Hip abductors Hip adductors Calf muscles	20 sec 2 times (rest 5 sec between sets)	6 min
Cool-down	Cervical and trunk stretching	15 sec 2 times	2 min

Statistical analysis

The data analysis was performed using SPSS for Windows version 20.0. The Kolmogorov–Smirnov test was used for normality. The Levene's F–test was used for homogeneity. Independent t–test was used to determine differences between manual therapy group and stretching exercise group. Paired t–test was used to determine within each group. Statistical significance level was set as α=.05.

RESULTS

In the result of pelvic deviation, there was no significant difference between the two groups. There was a significant difference between the pre– and post–test of the manual therapy group. There was a significant difference between the pre– and post–test of the stretching exercise group (Table 4).

In the result of functional leg length inequality, there was no significant difference between two groups. There was a significant difference between the pre– and post– test of the manual therapy group. There was no significant difference between the pre– and post– test of the stretching exercise group (Table 4).

In the result of plantar pressure, there was no significant difference between the two groups. There was a significant difference between the pre– and post– test of the manual therapy group. There was no significant difference between the pre– and post–test of the stretching exercise group (Table 4).

In this study, the pelvic deviation did not show any significant difference between the groups. However, the pelvic deviation was significantly decreased between the pre– and post–test of the manual therapy group and stretching exercise group. The functional leg length inequality did not show any significant difference between the groups. The functional leg length inequality was decreased between the pre– and post–test of the manual therapy. There was no significant difference between the pre– and post–test of the stretching exercise group. The plantar pressure did not show any significant difference between the groups but the functional leg inequality was decreased between the pre– and post–test of manual therapy. There was no significant difference between the pre– and post–test of the stretching exercise group.

DISCUSSION

The balance and alignment of the body collapse, causing postural imbalance. The change affects the muscles in forms of shortening and lengthening, as well postural deformities. The difference of leg length due to pelvic malalignment causes spinal diseases such as scoliosis and kyphosis. The asymmetrical spinal deformities were left, leading to mechanical pressure on the heart, digestive organs, and internal organs. They also defeat the functions of the organs [12]. This study analyzed the changes in pelvic deviation, functional leg length difference, and plantar pressure according to manual therapy for 4 weeks in pelvic malalignment.

A study reported that the results of the manual therapy in clinical back problems extended thoracic back less, reduced the inclination of the pelvis, and improved the symmetry of the pelvic motion pattern, so it had significant changes in thoracolumbar and pelvic kinematics [13]. Static stretching exercise of

Table 4. The results of pelvic deviation, functional leg length, and plantar pressure

Variables	Group	Pre–test	Post–test	p
Pelvic deviation (mm)	Manual therapy	10.600±6.501	2.400±1.776*	.353
	Stretching	10.200±3.327	1.800±1.932*	
Functional leg length inequality (mm)	Manual therapy	1.500±.850	.380±.175*	.550
	Stretching	1.140±.928	.750±.721	
Plantar pressure (%)	Manual therapy	6.260±4.906	1.820±1.677*	.651
	Stretching	4.340±3.339	3.260±2.059	

Values are showed Mean ± SD
*p⟨.05; significant difference between pre– and post–test

short hamstring muscles has significantly increased the maximal hamstring length and maximal resistance to passive stretch [14]. A previous study showed that manual therapy improved functional leg length difference and balance due to the asymmetry of the left and right hip bones by restoring the position and movement of hip bone [15, 16]. A study conducted to evaluate the effect of pelvic adjustment in functional leg length inequality and foot pressure among adults with functional leg length inequality of at least 10 mm for 4 weeks, the pelvic adjustment reduced functional leg length inequality and foot pressure difference. Additionally, foot pressure difference was reduced in proportion to the decrease in the functional leg length inequality [17]. Another study examined the effect of pelvic adjustment using the Gonstead technique, one of the manual therapy methods, on the stability of elderly men. The study resulted with stability being significantly improved after the pelvic adjustment technique [18].

In this study, the pelvic deviation did not show any significant difference between the groups but the pelvic deviation was significantly decreased between the pre- and post-test of manual therapy group and stretching exercise group. The functional leg length inequality did not show significant difference between the groups. The functional leg inequality was decreased between the pre- and post-test of manual therapy. There was no significant difference between the pre- and post-test of stretching exercise group. The plantar pressure did not show any significant difference between the groups; however, the functional leg inequality was decreased between the pre- and post-test of manual therapy. There was no significant difference between the pre- and post-test of the stretching exercise group.

In this study, there were significant differences between the pre- and post-test of the manual therapy group in the pelvic deviation, the functional leg length inequality, and plantar pressure. The manual therapy changed the symmetry of the pelvic motion pattern in the subjects who had pelvic malalignment and with positively changed pelvic alignment. The change of the pelvic deviation would affect the functional leg length inequality and decrease the difference of functional leg length; subsequently, the decreased functional leg length would change the plantar foot pressure distribution. In the stretching exercise group, there was significant difference between the pre- and post-test in the pelvic deviation but no significant difference between the pre- and post-test in the functional leg length inequality and the plantar pressure. The stretching exercise could change the length of the pelvic muscles and the symmetry of the pelvic motion pattern. The changed symmetry decreased the pelvic deviation but the degree of the decreased pelvic deviation has not changed significantly the functional leg length inequality and plantar pressure.

In conclusion, the manual therapy decreased the pelvic deviation, functional leg length inequality, and difference of the plantar pressure distribution. The stretching exercise decreased the pelvic deviation. In other words, the manual therapy improved the alignment of the pelvis and lower extremity in pelvic malalignment whereas stretching exercise improved the pelvic alignment. The finding may help in the study which performs manual therapy, and in clinical areas applying manual therapy on malalignment and postural instability such as scoliosis and general instability.

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