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Short-term Effects of Lumbar Rotation Mobilization on the Single-Leg Standing Balance Ability in Healthy People: A Pilot Study

The purpose of this study was to investigate the short-term effects of lumbar rotational mobilization under the single-leg standing (SLS) position. Fifteen healthy individuals were recruited, and randomized to agroup of trunk rotational exercise (TRE) and lumbar rotational mobilization (LRM). Trunk twist rotational exercise was performed to the TRE group, and mobilization was applied to the LRM group on the lumbar spine. Velocity of the center of pressure (VCOP) and center of pressure (COP) for each participant were measured through SLS. COPs were not significantly increased or decreased after treatment in both groups. VCOPs also did not change considerably except on the right side when the eye was closed. There was no significant difference between COPs and VCOPs in two groups. This study suggests that trunk rotation exercise and lumbar rotation mobilization would have similar effects on balance ability.

Key words: *Lumbar rotational mobilization, Trunk rotational exercise, Center of pressure, Velocity of the center of pressure*

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INTRODUCTION

The use of passive intervertebral mobilization has been advocated as a method for assessing spinal stiffness as well as for treating spinal disorders [1]. Lumbar joint mobilization has been commonly used by physical therapists to reduce pain and increase the range of motion in patients with low back pain. When it is applied appropriately, this intervention poses a low risk of injury and may result in immediate detectable improvements in patient's conditions [2]. Applying rotational movement to the vertebrae causes one facet joint to be compressed and the other facet joint to separate. Then, if the facet joint would be compressed, separated, the intervertebral foramen widens, or the intervertebral foramen narrows, the movements could contribute to those statuses. These findings suggest that the widening of the intervertebral foramen may reduce the compression of the nerve roots and increase the nerve conduction velocity [3, 4]. PAUL F. et a [12] reported that a 10 minute session of lumbar joint mobilization consisting of posteroanterior(PA) pressures and lumbar rotation resulted in a significant mean increase in the diffusion of cerebrospinal fluid (CSF) in degenerative intervertebral discs at the L5-S1 level. There is evidence that nociceptor activity giving rise to pain also generates great reflex effects; there is similar evidence that the simple passive movement of joints likewise generates reflex effects [5].

Joint mobilization has been exhibited to alter muscle force output and activation. Specific to the changes in muscle force output and activation have been documented in the quadriceps [6, 7, 8], hamstrings [9], gastrocnemius [10, 11, 12, 13, 14], and soleus [15]. Joint mobilization is thought to stimulate sensory receptors inside and around the joint and affects the central nervous system at the spinal segmental level [6, 15, 16, 17, 18, 19, 20]. The implicated neurophysiological effect may be dependent on the low grade of joint mobilizations applied during the manual intervention [12, 13].

Recently, specific body movements induced from poor balance status have been reported, one of the essential functions of the trunk would be to efficiently handle external loads to ensure dynamic or high-intensity activity, performance, and stability during the body in daily life [21, 22]. Among well-known exercises, core stability exercise is the typical maneuver to improve the trunk stability [23, 24]. So far most of the studies have been applied in different ways by applying strengthening exercises [25, 23]. Recently, sensorimotor training or neuromuscular training or combination implements have introduced for trunk strengthening [22, 25]. These sensorimotor and neuromuscular exercises contributed to improving the lower leg stability [26].

The postural control is the ability to control the center of gravity [27]. Physiological sensorimotor subsystems such as vision, vestibular output, lower limb proprioception, and cognition contribute to upright postural control [28, 29]. Among the methods of measuring posture control, single-leg standing (SLS) is a more challenging and economical method. Single-leg balance (SLB) or SLS test measures the center of pressure, the center of pressure of velocity and standing time while the subject is standing without supporting single-leg [30, 31]. This test is a clinical method to measure the postural steadiness or balance ability in a static position [32]. SLS is also suggested to be related to the injury occurrence and performance in a variety of athletes [33].

There are many studies applied PA to the lumbar spine, but researches of rotational joint mobilization seemto be lacked. In addition, there is alittle evidence to support the rationale for the reason of effect onto lumbar mobilization on balance ability. For these reasons, this study hypothesized that physiological lumbar rotation also caused neurophysiologic changes like other vertebral mobilization, which in turn would affect balance.

SUBJECTS AND METHODS

Subjects

Fifteen subjects (5 men and 10 women, mean age=22.81 (SD=1.21), mean height=165.70cm (SD=11.49), mean weight=61.56kg (SD=8.14) agreed to be participated in this study. This study included persons who could stand with a left foot within 20 seconds and had no pain in their legs, buttocks, and backs. Participants who underwent surgery around the hip, hip, or hip within 12 months were excluded. The final participants are 15 people. The dominant foot of the participant estimated right side. Participantswere informedon the general progress and any potential progress prior to the written consent form.

Study Design and Sequences

This study is a single-center, double-blinded, randomized controlledclinical study. All individuals participating in lumbar rotational mobilization (LRM) and trunk rotational exercise (TRE) were measured before and after interventions. After each trial, they had eight days of wash-out periods. Single-Legged Balance (SLB) test was chosen to make outcomes (Fig. 1).

Randomly allocated data groups were performed after the measurement by an appointed teaching assistant working at IUK using opaque envelops, in blocks of 2 participants, to ensure a blind in each group; independent evaluators were appointed, who performed all the evaluations in a single-blind manner. They were not involved in the allocation procedure or treatment of either the LRM or TRE group. Examiner was trained in standardized clinical assessments during 3-days of meeting together with the coordinating researchers.

Participants were randomly assigned, 8 performed LRM, and 7 performed TRE. The effect of an intervention on SLS was measured by the platform (RM Ingenierie, France). After the 8-day wash-out period, those who participated in the LRM performed the TRE, and those who participated in the TRE performed the LRM. All of the dependent variables were measured in the same manner four times. In this way, the total number of LRM and TRE data is 15, and each data group was compared.

Study interventions

Lumbar rotation mobilization (LRM)

Right and left rotation mobilization techniques (grade 3 and grade 4) described by Maitland [34] applied on from lumbar vertebra 1 to 5 for ten minutes in this study. The participants were introduced to each side-lying position on the plinth for 5 minutes. The initial starting position adopted was side-lying with flexion of the top leg (flexion of both hip and knee) and extension of the bottom leg. In grade 3, the body was twisted further to the left by pulling the left arm-touching the floor. In the grade 4, an additional twist force on lumbar was obtained by hanging the upper leg over the plinth edge. Counter pressure applied to

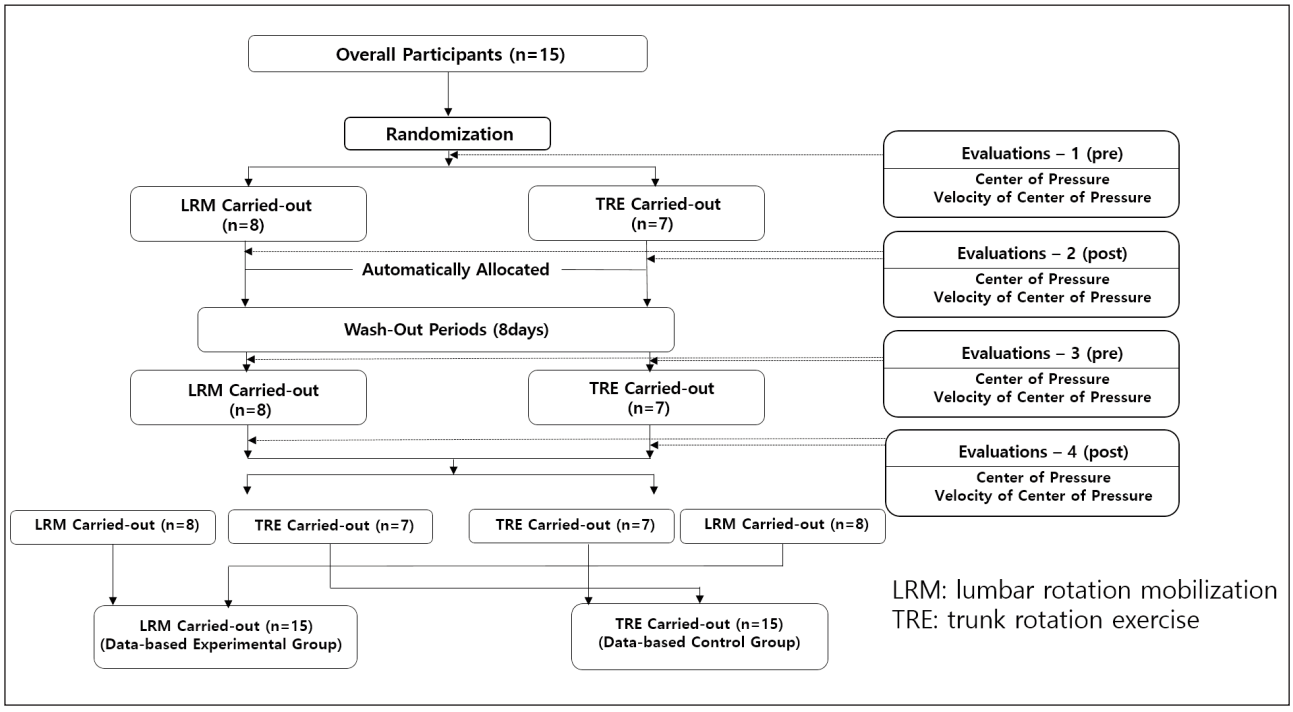

Fig. 1. Flow diagram of data arrangementand allocation sequence design

the shoulder during the pelvis was pushed for the more stronger grades of 3 and 4. Grade 4 is smaller in amplitude than grade 3 as described by Maitland. The therapists made a personal perspective; if there is decreased movement from certain lumbar, they put the focus on this area. The therapist completed Maitland educational courses and had more than five years of clinical experience in the musculoskeletal physical therapy. The applied force depends on the perception of the therapist, and the treatment grade was judged by clinical experience. LRM was implemented for 10 minutes without resting time.

Trunk rotation exercise (TRE)

The researchers were forming on two-feet and taking an anatomical posture in this procedure. Then push participant's right foot forward and take a lunge posture. The palms were addressed to be crossed on opposite forearms and turn to the right to the end range. When the participants were introduced immediately bring the body back to the neutral position after trunk rotation, they were led to gathering the two feet to take the first posture. The left side also exercises in the same way. One set of right and left was set as one set. The total number of exercises was ten times of sets without resting time.

Outcome Measures (SLST)

For the evaluation of SLST, the participants performed with their eyes opened since the participants usually might to fell on the floor; arms crossed on the chest during unassisted on single-leg, the other leg should be 90 degrees of hip and knee flexed. We measured these process for 15 seconds,and the center of pressure (COP) and velocity of the center of pressure (VCOP) of each participant was induced to measure through SLS. COP and VCOP were measured in eyes and eyes closed, and both feet were measured. The COP and VCOP were inversely proportional to the balance ability. For example, if the area is large and the speed is high, the balance ability is decreased. The examination and treatment were carried out by different persons in all experimental procedures.

Study interventions

Thestatistical analysis was performed with SPSS Version 20.0 to study the effects of spinal mobilization on the dependent variables - COP and VCOP. The paired t-test is used to test the significance mean the difference between each group and the independent test is used to test the significant mean difference between the groups.Statistical significance was accepted at the 5% of the level.

RESULTS

Within-group differences

The COP of the LRM decreased when standing with the right foot an eye open and eye closed, however, increased during standing with the left foot in eye closed. The COP of the TRE group did not show any changes in a certain pattern. The VCOP of the LRM group also decreased when standing with the right foot, however, increased during standing with the left foot both in eyes and eye closed. The only significant increase in VCOP was during right leg standing in the eye closed ($p < .05$). The VCOP of the TRE group showed increasedperformance during standing with the eye open, however, reported decreased during standing with eye closed.

Between-group differences

The VCOP in the eye closed was significantly smaller than that of LRM only in the right foot ($p < .05$), and there was no significant difference in the left foot. There was no statistically significant difference in COP in eyes closed when TRE was smaller than LRM in both feet. The VCOP of the TRE was not statistically significant, however, was less than the VCOP of the LRM in eye open and eye closed.

DISCUSSION

The purpose of this study was to evaluate the short-term effects of lumbar rotation mobilization on the SLS ability. In this finding, lumbar rotation mobilization (LRM) could serve to decreasing COP and VCOP during SLS balance. The COP is the center of the distribution of the total force applied to the supporting surface on a body [35]. Smaller COP means better balance ability in the human body [28]. The movement of the COP varies depending on the movement of the COG, and it also depends on the projection of the muscle forces required to control or produce the movements [36]. VCOP represents the total distance traveled by the COP over time [37]. Numerous researchers and clinicians have used VCOP to assess changes in COP. An increase in VCOP is thought to represent a decreased ability to control posture, whereas a decrease in the velocity represents an increase in the ability to maintain an upright stance [38, 39, 40, 41, 42].

Joint manipulation has been exhibited to the lower extremity changes in muscle force output and activation has been demonstrated. Also, acutely increase quadriceps force output [6, 7, 8] and quadriceps activation [6, 7].

There are some possible explanations for our result. The results of this study indicate that the COP and

Table 1. Mean value of COP and VCOP of the lumbar rotation mobilization or trunk rotation exercise

			Lumbar Rotation Mobilization		Trunk Rotation Exercise	
			Before	After	Before	After
COP (mm^2)	Eye Open	Left	222.29±403.11	192.31±138.09	256.07±311.01	332.43±452.98
		Right	223.69±268.69	173.38±147.57	222.84±260.64	302.07±258.64
	Eye Closed	Left	690.70±495.29	3782.85±6487.82	1996.86±2327.49	1511.14±1115.56
		Right	1159.23±1034.60	930.00±896.63	1736.50±1683.98	1676.43±1623.37
VCOP (cm/s)	Eye Open	Left	1.62±1.28	1.37±0.61	1.51±0.75	1.79±1.27
		Right	1.61±1.04	1.45±0.39	1.53±0.68	1.74±0.91
	Eye Closed	Left	3.37±1.11	4.54±2.46	4.49±2.16	4.74±1.96
		Right	4.05±1.62	3.34±1.36*	5.04±3.11	4.72±2.16

The values were expressed as the mean±SD.
COP: center of pressure; VCOP: velocity of the center of pressure
* Significance mean difference in each group ($p < .05$)
† Significant difference between groups Lumbar Rotation Mobilization and Lumbar Rotation Exercise ($p < .05$)

VCOP of the LRM decreased when standing with an eye open, however, increased during standing with the left foot in eye closed. In contrast, the COP of the TRE decreased or increased in an uncertain pattern. An increase in postural sway can be considered as an increase in postural instability [29]. The changes between the groups are as follows. After the intervention, the variables were generally higher the COP of TRE than in the LRM with an eye open, and COP of LRM was increased compared with TRE when left foot standing with an eye closed.

Interestingly, while standing on the right foot with your eyes closed, the VCOP of the LRM was significantly reduced, suggesting an improvement in balance capability ($p<.05$). However, the VCOP of the TRE was decreased but not statistically significant, which means an increase in the balance ability. The noteworthy point is that the COP and VCOP of LRM are mostly decreased while the TRE is mostly increased after the intervention.

However, this study did not identify structural changes with MRI, it cannot be fully convinced that mechanical changes have had a therapeutic effect [43]. However, since the above reductions are somewhat real, the balance ability will have been increased after lumbar mobilization treatment.

CONCLUSION

This can be considered as LRM is a more effective way to improve balance ability than TRE. However, one of the essential facts, when comparing COP and VCOP changes within the group, overall decrease in LRM and increase in TRE. In other words, decreasing COP and VCOP mean improved balance. In conclusion, the findings of this study suggest that LRM is a more effective method than TRE.

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