



Original Article

The effects of dynamic exercise using the proprioceptive neuromuscular facilitation pattern on posture in healthy adults

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Abstract. [Purpose] The purpose of this study is to examine the effects of dynamic exercise utilizing the proprioceptor neuromuscular facilitation pattern accompanied by abdominal drawing-in exercises on posture in healthy adults. [Subjects and Methods] The total number of subjects were 32; 16 were randomly placed in the training group, and the remaining 16 made up the control group. The subjects in the training group conducted 5 sets of dynamic exercises utilizing the proprioceptor neuromuscular facilitation patterns each day, 3 times a week for 6 weeks. Using BackMapper, their trunk inclination, trunk imbalance, pelvic position, pelvic torsion, pelvic rotation and the position of their scapula were evaluated. [Results] When the training group's posture pre-test and post-test were compared in this study, there was a statistical significance in trunk inclination, pelvic position, pelvic torsion, pelvic rotation and the position of their scapula. [Conclusion] Dynamic exercise utilizing the proprioceptor neuromuscular facilitation patterns increased the posture that are the basis of trunk stabilization.

Key words: Dynamic exercise, Proprioceptor neuromuscular facilitation patterns, Posture

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INTRODUCTION

The development of industrial society has increased the amount of sedentary time humans engage in and the resulting dysfunction caused by insufficient exercise. Being sedentary over long periods of time can weaken the muscular strength of the abdomen, resulting in incorrect posture and physical imbalance. The spinal deformity caused by those factors may induce severe health problems and low back pain¹⁾. In particular, excessive biomechanical burden due to a sedentary lifestyle has been reported to induce muscular atrophy in the abdomen, muscular weakness, instability of the vertebral joints, pain around the lumbar vertebra, reduced endurance, and limitations in flexibility and range of joint motion²⁾. In upright posture, asymmetry is associated with various outcomes, such as decreased loading of the affected side in stroke, degenerative changes of the hip, knee, ankle joints, and spine, or leg length discrepancy³⁾.

Two types of trunk muscles are important for maintaining posture: generalized motor muscles and local stability muscles. Generalized motor muscles, such as the erector spinae and the rectus abdominis, are involved in movement by delivering the load between the backbone and the pelvis. Local stability muscles, such as the transversus abdominis and the multifidus, maintain the motion of the spine and posture when the weight load is applied to the backbone⁴⁾. Because stability of the spine and the pelvis is important for maintaining posture, trunk stability exercises have been widely used. Trunk stability exercises increase the stability of the spine and the pelvis; they strengthen the trunk muscles and enable individuals to recover control over and balance of their muscles and movements⁵⁾. In this context, this study examined a type of dynamic exercise that utilizes proprioceptive neuromuscular facilitation (PNF) patterns to improve posture. This type of exercise is effective for developing the multifidus, the internal obliquus abdominis (IOA), and the transversus abdominis (TRA) muscles, which play

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a significant role in stabilizing the lumbar spine⁶).

Similar studies on improving posture have reported that bridge exercises improved lumbo-pelvic stabilization and posture⁷ and a variety of mattress exercises have improved lumbo-pelvic stabilization and postures⁸. O'Sullivan et al. argued that stability exercises in a dynamic environment such as with therapeutic gym balls, rather than exercises in a static environment, could maximize an individual's balancing ability⁹. Page reported that exercise using unstable tools could be effective for maintaining correct posture or recovering somesthetic sensibility¹⁰. However, when a systematic program is organized under a professional trainer's supervision, plyometric exercises, circuit training, core stabilization exercises, bridge exercises, and mattress exercises must be performed using suitable devices in appropriate environments/places. Such limitations have made it difficult for healthy students or workers to use those types of exercises for posture correction. Although dynamic exercise using PNF patterns can be easily employed, regardless of the time and place in which they occur, few studies have investigated its effect on posture.

This present study performed a type of dynamic exercise using PNF patterns that can be conducted comfortably without limitations as to the place or the equipment for six weeks in order to identify changes in posture.

SUBJECTS AND METHODS

The subjects of this study were 32 students at Nazarene University in South Korea. The inclusion criterion was normal, healthy adults. Potential subjects were excluded from participating in the study if they were overweight, had a structural abnormality in the backbone, had spinal pain, such as backache, were taking medications, had neurological disorder(s), had consumed alcohol before the experiment, and exercised regularly. The included subjects were randomly divided into a training group (TG) (1 male; 15 females) and a control group (CG) (1 male; 15 females). The age, height and weight data for the TG were: 23.4 ± 2.1 years of age (mean \pm SD), 162.1 ± 3.0 cm, and 58.5 ± 3.6 kg, respectively. The age, height and weight data for the CG were: 22.9 ± 2.8 years of age (mean \pm SD); 163.5 ± 2.4 cm, and 57.7 ± 2.3 kg, respectively. A χ^2 test was used to analyze gender, while an independent sample t-test was used to analyze age, height, and weight; no statistically significant differences were observed ($p > 0.05$), indicating that there was no homogeneity problem between the two groups. This study was approved by Korea Nazarene University's Institutional Review Board (2016-0008), and the subjects were safely protected throughout every stage of the experiment. All of the subjects understood the purpose of this study and provided written informed consent prior to their participation in the study in accordance with the ethical standards of the Declaration of Helsinki.

To test the effectiveness of dynamic exercise using PNF patterns, the subjects in the TG underwent trunk stability testing by abdominal drawing-in, and then they performed dynamic exercise using PNF patterns, alternating to the left and to the right. First, when placing their left foot on a spot, they raised their right foot to lift their entire weight without movement while their left lower limbs were in hip extension, knee extension, and ankle plantar flexion, their right lower limbs were in hip flexion, hip adduction, hip external rotation, knee flexion, and ankle dorsiflexion, their left upper limbs were in shoulder flexion, adduction, external rotation, and elbow flexion, and their right upper limbs were in shoulder extension, shoulder abduction, shoulder internal rotation, and elbow extension. When they lowered their right foot, their left lower limbs were in hip flexion, knee flexion, and ankle dorsiflexion. When they lowered their posture, their right lower limbs were in hip extension, hip abduction, hip internal rotation, knee extension, and ankle plantar flexion. Then, they placed the tip of their right foot on a spot diagonally 70 cm to 80 cm from the right posterior to their left foot, while their right upper limbs were in shoulder flexion, adduction, external rotation, and elbow flexion, and their left upper limbs were in shoulder extension, shoulder abduction, shoulder internal rotation, and elbow extension. Then, the subjects placed their right foot on a spot to conduct the above exercise for their left foot in order to complete one dynamic exercise set using PNF patterns. During the exercise, it was important for the trunk to maintain a neutral stance, for the trunk and the supporting feet not to be moved, and for the foot touching a spot diagonally to touch the same spot throughout the exercise⁶. A total of 20 times (10 for the left and 10 for the right) was defined as one set. The subjects underwent five sets per day from the first to the third week, and eight sets per day from the fourth to the sixth week, three times per week for six weeks. A 30-sec rest was given between the sets, and a total of 25-to-30 minutes were needed to perform the exercise each day, including a five-minute warm-up exercise and a five-minute cool-down exercise. Meanwhile, the CG underwent the above-mentioned procedure twice without engaging in a specific exercise.

In order to identify postural changes before and after dynamic exercise using PNF patterns, we used the Back Mapper, a three-dimensional imaging system for vertebral diagnosis (ABW, Frickenhausen, Germany). This device relatively accurately measures and analyzes the shape and location of the spine and distortion of the pelvis as it observes the spine from every direction. In addition, it can be used to analyze trunk inclination (TIN), trunk imbalance (TIM), pelvic position (PPO), pelvic torsion (PTO) of the innominate bone, pelvic rotation (PRO), and position of scapula (PSA) by muscle expression, fat distribution, and the location of bones with a variety of variables.

The experimental results were statistically analyzed using Statistical Package for the Social Sciences (SPSS) version 18.0 KO (SPSS, Chicago, IL, USA). After determining the general characteristics of the subjects, paired t-tests were used to compare the changes in TIN, TIM, PPO, PTO, PRO, and PSA for the pre-test and post-test in each group. The differences between the two groups were tested using independent t-tests. The statistical significance level, α , was set at 0.05.

Table 1. Comparison of TIN, TIM, PPO, PTO, PRO and PSA between pre- and post-test in each group (mean ± SD) (unit: TIN, TIM, PPO, PTO, PRO-degree, PSA-mm)

Category	Group	Pre-test	Post-test
TIN	Training G*	2.56 ± 1.36	1.43 ± 0.72
	Control G	2.43 ± 0.89	2.31 ± 1.30
TIM	Training G	2.43 ± 2.25	1.31 ± 0.60
	Control G	2.31 ± 1.44	2.18 ± 1.16
PPO	Training G*	2.25 ± 0.85	1.43 ± 0.62
	Control G	2.31 ± 1.25	2.43 ± 1.15
PTO	Training G*	2.68 ± 1.30	1.87 ± 0.88
	Control G	2.50 ± 1.89	2.56 ± 1.50
PRO	Training G*	2.43 ± 0.89	1.50 ± 0.63
	Control G	2.25 ± 1.57	2.12 ± 1.50
PSA	Training G*	4.25 ± 1.91	2.87 ± 1.25
	Control G	4.12 ± 1.85	3.56 ± 1.99

*p<0.05, G: group; TIN: trunk inclination; TIM: trunk imbalance; PPO: pelvic position; PTO: pelvic torsion; PRO: pelvic rotation; PSA: position of scapulae

Table 2. Comparison of TIN, TIM, PPO, PTO, PRO and PSA between training group and control group (mean ± SD) (unit: TIN, TIM, PPO, PTO, PRO-degree, PSA-mm)

	Category	Training G	Control G
Pre-test	TIN	2.56 ± 1.36	2.43 ± 0.89
	TIM	2.43 ± 2.25	2.31 ± 1.44
	PPO	2.25 ± 0.85	2.31 ± 1.25
	PTO	2.68 ± 1.30	2.50 ± 1.89
	PRO	2.43 ± 0.89	2.25 ± 1.57
	PSA	4.25 ± 1.91	4.12 ± 1.85
Post-test	TIN*	1.43 ± 0.72	2.31 ± 1.30
	TIM*	1.31 ± 0.60	2.18 ± 1.16
	PPO*	1.43 ± 0.62	2.43 ± 1.15
	PTO	1.87 ± 0.88	2.56 ± 1.50
	PRO	1.50 ± 0.63	2.12 ± 1.50
	PSA	2.87 ± 1.25	3.56 ± 1.99
Change between pre- and post-test	TIN	1.12 ± 1.40	0.12 ± 1.54
	TIM	1.12 ± 2.21	0.12 ± 1.25
	PPO*	0.81 ± 1.04	-0.12 ± 1.45
	PTO	0.81 ± 1.37	-0.06 ± 3.10
	PRO	0.93 ± 1.18	0.12 ± 2.09
	PSA	1.37 ± 1.96	0.56 ± 2.68

*p<0.05

RESULTS

Between the pre- and post-exercise, the TG showed statistical significance in TIN, PPO, PTO, PRO, and PSA (p<0.05); no statistical significance was observed in the CG for any of the items (p>0.05) (Table 1). When the pre-, post-, and pre-post exercise values were compared for the two groups, no statistical significance was found for the pre-exercise values (p>0.05); in the post-exercise evaluation, the TIN, TIM, and PPO values were found to be statistically significant for both groups, but only the PPO values were found to be statistically significant in the pre-post exercise evaluation (p<0.05) (Table 2).

DISCUSSION

Correct posture can affect an individual's appearance as well as the efficiency of a person's physical functions. This study investigated the effects of a type of dynamic exercise using PNF patterns on the posture of healthy adults. Recently, trunk stability exercises have been utilized for posture control because they play an important role in the stabilization and postural control of the trunk by activating the muscles in the abdomen and the spine, simultaneously and harmoniously, through trunk training¹¹.

A variety of recent studies have investigated trunk stabilization. Ainscough-Potts et al. applied a five-week core exercise program using Swiss balls to 30 healthy female adults in order to improve the stability of their sedentary posture¹². Some researchers have argued that a sling exercise reduces the pelvic inclination caused by imbalanced muscles by stimulating the muscles around the lumbar-pelvic-hip to stabilize the body core¹³. Gong reported that dynamic exercise utilizing PNF patterns contribute to the fact that through abdominal drawing-in, diagonal and spiral exercises of the pelvis, shoulder blade, and the upper extremities were performed continuously while trunk stability was maintained so that abdominal deep muscles, that is, the core, was activated. In particular, it can be seen that, through abdominal drawing-in, muscle thickness of not only the external obliquus abdominis, which is a superficial muscle, but also the internal obliquus abdominis, and the transversus abdominis muscles, which are deep muscles, increased⁶. Brill proposed that core stabilization exercises can maintain spinal balance based on contraction of the transverse abdominis, thereby increasing lumbar muscle strength and stability¹⁴. Myer proved that plyometrics and core stabilization exercises were effective in controlling the nerve roots and muscle power after having female high-school athletes perform such exercises three times a week for seven weeks¹⁵.

In terms of posture, Cho reported that pelvic adjustment with the Gonstead technique was found to have a positive effect on postural changes in 30 female college students who were divided into a pelvic adjustment group (n=15) and a stretching group (n=15)¹⁶.

In this present study we divided 32 healthy adults into a TG and a CG, and then engaged the TG in dynamic exercise using

PNF patterns three times per week for six weeks. We observed statistically significant differences in TIN, PPO, PTO, PRO and PSA for the TG group between the pre- and post- experiment values. The abnormal deep muscles were activated by the diagonal and spiral movements that occur continuously between the pelvis and the lower limbs and the scapulae and the upper limbs, while the trunk was stabilized by abdominal drawing-in. The activation might improve trunk stabilization, leading to positive effects on posture. In this context, dynamic exercises using PNF patterns as a type of stabilization exercise may be recommended for postural correction for students and workers who have time and place limitations for engaging in exercises.

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