The Effects of PNF Rhythmic Dance on the Change of Static Balance Ability in Young Adults

This study was to investigate the effects of upper and lower limb composing patterns of PNF (proprioceptive neuromuscular facilitation) on the static balance ability by 20 subjects for 6 weeks. This study was measured left one leg standing and right one leg standing with closed eyes on Good Balance system. These results led us to the conclusion that the mean speed of X, Y direction, COP (center of Pressure) velocity moment showed a statistical decrease when applying post-exercise. The above results from this study indicated that upper and lower limb composing patterns of PNF exercise has improved the static balance ability.

As a result, this study showed that upper and lower limb composing patterns exercise improve the ability of balance in young adults. Based on this study, it may be applied to old people.

Key words: Proprioceptive Neuromuscular Facilitation(PNF): Good Balance System: Center of Pressure(COP): Balance

INTRODUCTION

We could perhaps state that to minimize controlling or maintaining equilibrium on the position of the human body is dependent on the environment and it may be involved in the activities. Equilibrium is the ability to maintain the body center of gravity over its base on minimal sway(1).

The integration of the nervous and skeletal system deals with a variety of complex functions, which combined influx of stimulus from visual, auditory, equilibrium and proprioceptive senses to the central nervous system along with visual space perception, rapidly adaption to environmental changes and accurately responding muscle tensity, muscle strength, endurance and the flexibility of joints with other multiple functions and if damaged the performance ability, the related to maintain balance can be lost(2).

The ability of static balance is opposed to the gravity force over the fixed base of support which forces the body to maintain the upright position, whereas the dynamic balance ability maintains original posture without falls while in motion(3).

The proprioceptive sensory perceives the posture of the body in space, it related to motor senses, consciousness of body position, weight sensation and the muscular system. It maintains balance through information and support from the vestibular organ and normalizes major tensions while controlling postures and motions of the body(4). The method see to stimulate the proprioceptive by utilizing various technological aids, proprioceptive neuromuscular facilitation(PNF), the muscular strength. Flexibility and coordination performance ability are improved when the nervous system is stimulated and the overall coordination training performance ability has increased in a response to it. Therefore, the prompting a stronger response each time seems to be the most effective physical therapy(5).

The present research aims to discover how effective the statical balancing ability of a normal individual can be improved when a combined pattern of proprioceptive neuromuscular therapy is applied, using the
single leg stance and visual block methods. The single leg stance is an essential element to perform the so many daily activities we are engaged on walking, running, changing direction, using the stairs(6).

Also evaluations of many vital dynamics scholars conduct on safety and balance of the body through measuring the variables from the center of pressure and ground reaction force whereas the characteristics obtained the center of pressure from motion are used to build assumptions of posture control in neurology and dynamic mechanism. Through this studies, we aim to provide basic knowledge in physical therapy to the aging population as well, which sees a decreasing balance ability in themselves.

**MATERIALS AND METHODS**

**Subjects and Experimental Procedure**

The subjects of this study were 20 young adults. Experimental procedure was maintained for 6 weeks, 3 times a week, 5 min in a day with dance music. Rhythmic dance was compounded diagonally: up, down, flexion, stretching components. Mean speed of X, Y direction and COP (center of pressure) velocity moment has been measured in pre-test. After PNF dancing, the mean speed of X, Y direction and COP velocity moment was measured in post-test.

**Exercise Pattern**

**Pattern 1(Fig. 1).**

Rt, Scapular anterior depression & Shoulder extension-adduction-internal rotation & Elbow extension-pronation & Wrist flexion-ulnar deviation & Finger flexion(Diagonal down stretching)
Lt, Knee joint extension & Hip joint extension-adduction-internal rotation & Ankle joint plantar flexion-eversion & Toe flexion(Diagonal down stretching)

**Pattern 2(Fig. 2).**

Rt, Scapular anterior depression & Shoulder extension-adduction-internal rotation & Elbow extension-pronation & Wrist flexion-ulnar deviation & Finger flexion(Diagonal down stretching)
Lt, Knee joint extension & Hip joint flexion-adduction-external rotation & Ankle dorsiflexion-inversion & Toe extension(Diagonal up stretching)

**Pattern 3(Fig. 3).**

Rt, Scapular posterior elevation & Shoulder joint flexion-adduction-external rotation & Elbow extension-supination & Wrist flexion-ulnar deviation & Finger flexion(Diagonal up stretching)
Lt, Knee joint flexion & Hip joint extension-adduction-internal rotation & Ankle plantar flexion-eversion & Toe flexion(Diagonal down flexion)

**Pattern 4(Fig. 4).**

Rt, Scapular anterior depression & Shoulder extension-adduction-internal rotation & Elbow extension-pronation & Wrist flexion-ulnar deviation & Finger flexion(Diagonal down stretching)
Lt, Knee joint flexion & Hip joint flexion-adduction-external rotation & Ankle dorsiflexion-inversion & Toe extension(Diagonal up flexion)

**Pattern 5(Fig. 5).**

Rt, Scapular posterior elevation & Shoulder joint flexion-adduction-external rotation & Elbow extension-supination & Wrist extension-ulnar deviation & Finger extension(Diagonal up stretching)
Lt, Knee joint extension & Hip joint extension-adduction-internal rotation & Ankle joint plantar flexion-eversion & Toe flexion(Diagonal down stretching)

**Pattern 6(Fig. 6).**

Rt, Scapular posterior depression & Shoulder joint extension-adduction-internal rotation & Elbow extension-pronation & Wrist flexion-ulnar deviation & Finger flexion(Diagonal down stretching)
Lt, Knee joint extension & Hip joint flexion-adduction-external rotation & Ankle dorsiflexion-inversion & Toe extension(Diagonal up stretching)

**Pattern 7(Fig. 7).**

Rt, Scapular posterior depression & Shoulder joint extension-adduction-internal rotation & Elbow extension-pronation & Wrist flexion-ulnar deviation & Finger flexion(Diagonal down stretching)
Lt, Knee joint flexion & Hip joint extension-adduction-internal rotation & Ankle plantar flexion-eversion & Toe flexion(Diagonal down flexion)
Fig. 1. Pattern 1
Fig. 2. Pattern 2
Fig. 3. Pattern 3
Fig. 4. Pattern 4
Fig. 5. Pattern 5
Fig. 6. Pattern 6
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**Table 1. Measurement variables**

<table>
<thead>
<tr>
<th>Measurement variable</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mean X speed in center of pressure</td>
<td>mm/s</td>
</tr>
<tr>
<td>2 Mean Y speed in center of pressure</td>
<td>mm/s</td>
</tr>
<tr>
<td>3 Velocity moment in center of pressure</td>
<td>mm/s</td>
</tr>
</tbody>
</table>

**Data Analysis**

Ability change of balance was measured by Good Balance System, Ver 3.06 (METITTUR, USA). Good Balance System measure of dynamic balance ability and static balance ability. The system measured mean X speed, mean Y speed, velocity moment on performing to subject.

**RESULTS**

**General Characteristics of Subject**

A general characteristic of subjects seems to be Table 2.

**Table 2. General characteristics of subjects**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>20.15 ± 1.78</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>165.15 ± 6.74</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>57.35 ± 9.32</td>
</tr>
</tbody>
</table>

**The Comparisons of the Left One Leg Standing Mean X Speed**

The static balance coordination before the PNF rhythmic dance: $51.24\pm11.85$ mm/s. The static balance coordination after the PNF rhythmic dance: $43.52\pm8.63$ mm/s. With a mean difference of $7.72\pm12.36$ mm/s showing a noticeable decrease ($p<0.05$) (Table 3, Fig. 10).

**Table 3. Summary of measure of the left one leg standing mean X speed differences the group of PNF rhythmic exercise on static balance control**

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Mean X speed (mm/s)</td>
<td>before after</td>
<td></td>
</tr>
<tr>
<td>51.24 ± 11.85</td>
<td>43.52 ± 8.63</td>
<td>.012*</td>
</tr>
</tbody>
</table>

*p<0.05  **p<0.01
The Comparison of the Left One Leg Standing Velocity Moment

The static balance coordination before the PNF rhythmic dance is 469.07±178.35mm/s. The static balance coordination after the PNF rhythmic dance is 315.09±114.57mm/s. With a mean difference of 153.61±55.18mm/s, showing a noticeable decrease (p<0.05)(Table 5)(Fig. 12).

Table 5. Summary of measure of the left one leg standing velocity moment difference of the group of PNF rhythmic exercise on static balance control

<table>
<thead>
<tr>
<th></th>
<th>Mean±SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Velocity moment</td>
<td>before 469.07±178.35</td>
<td></td>
</tr>
<tr>
<td></td>
<td>after 315.09±114.57</td>
<td>.003**</td>
</tr>
</tbody>
</table>

The Comparisons of the Right One Leg Standing Mean X Speed

The static balance coordination before the PNF rhythmic dance: 48.37±8.34mm/s. The static balance coordination after the PNF rhythmic dance: 40.52±8.31mm/s. With a mean difference of 7.85±9.87mm/s showing a noticeable decrease (p<0.05)(Table 6)(Fig. 13).

Table 6. Summary of measure of the right one leg standing mean X speed difference of the group of PNF rhythmic exercise on static balance control

<table>
<thead>
<tr>
<th></th>
<th>Mean±SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Mean X speed</td>
<td>before 48.37±8.34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>after 40.52±8.31</td>
<td>.003**</td>
</tr>
</tbody>
</table>
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**The Comparison of the Right One Leg Standing Mean Y Speed**

The static balance coordination before the PNF rhythmic dance is 47.46±10.61mm/s. The static balance coordination after the PNF rhythmic dance is 37.04±8.58mm/s. With a mean difference of 10.42±12.26mm/s, showing a noticeable decrease (p<.05) (Table 7)(Fig. 14).

**Table 7.** Summary of measure of the right one leg standing mean Y speed difference of the group of PNF rhythmic exercise on static balance control

<table>
<thead>
<tr>
<th>Mean ±SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Mean Y speed (mm/s)</td>
<td>before</td>
</tr>
<tr>
<td></td>
<td>after</td>
</tr>
</tbody>
</table>

**The Comparison of the Right One Leg Standing Velocity Moment**

The static balance coordination before the PNF rhythmic dance is 469.07±178.35mm/s. The static balance coordination after the PNF rhythmic dance is 325.53±118.29mm/s. With a mean difference of 143.53±180.49mm/s showing a noticeable decrease (p<.05)(Table 8)(Fig. 15).

**Table 8.** Summary of measure of the right one leg standing velocity moment difference of the group of PNF rhythmic exercise on static balance control

<table>
<thead>
<tr>
<th>Mean ±SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Velocity moment (mm/s)</td>
<td>before</td>
</tr>
<tr>
<td></td>
<td>after</td>
</tr>
</tbody>
</table>

**DISCUSSION**

The aging population is seeing a rapid growth in the world. Only in year 2000, this population already surpassed 7% of the total population in Korea, during foreseen in 10 years(2018) it would reach over a 14% (of older persons), in year 2026(over a 20%) it is expected to become a super-aged society(7).

All the biological changes related to aging go along with the decrease in proprioceptive sensory abilities, which the righting reflex slows down, the muscular strength that maintains posture weakens, and maintaining balance becomes more difficult as agitation of the posture itself increases(8). Falls are suddenly happened due to coincidental loss of balance, limiting the functionality of active independent daily life
motions(9).

It is a need to work on improving and strengthening the aging communities’ muscles and balance abilities. It is important to keep the body upright and to maintain the stability in the spine through standing and sitting position. Therefore, its factor is properly important performance(10). Also, muscular strength of lower body of the old persons, walking ability and the ability to maintain balance are known to be related(11). Especially among the muscles of the lower body, sprain of knee joint and ankle effects they bring to the ability in maintaining balance have been the focus of our study and it seems like there is loss of the ability when the plantar flexor of the ankle weakens(12).

Balance affects all daily motions. We performed maintaining the body in an upright position(13).

Also, balance, integration of sensory information, processing information from the nervous system, and all the factors that include the complicated control process of bio-mechanical motor tasks(14). In order to perceive the body of the presence of other bodily active presence, other multiple senses are required to process visual sensation, somatic sensory, proprioceptive, velamen, joint sensory receptors, and vestibular sensory. The application of these stimulus provides the information that will eventually decide to the position of the body, whereas the integration of the visual, vestibular and somatic sensory are in charge of perceiving balance control(15). PNF stimulates the proprioceptive located in between the muscles and joints, flexibility while increases sense of balance(16, 17).

As a therapy, the potential effectiveness of the PNF has the fact that it can satisfy all the steps, it goes through as well as the stipulated factors health, function, obstacles, under the international classification of function disability and health, ICF endorsed by the WHO as the best known therapy(18).

In order to promote PNF’s effectiveness, certain techniques such close contact or the location of the therapist’s hand, method of holding(manual contact). Oral command and communication, stretch, traction, approximation, rhythmic initiation, dynamic reversal, reversal of antagonist, slow reversal are used in an integrated manner as well as replication, repeated contraction, repeated stretch, timing for emphasis, combination of isotonic, contract–relax, hold–relax, stabilizing reversal are other methods.

Exercises such as the repeated contraction, stretch, and isotonic were the ones used to build the base of the present study.

Also, when these exercises were implemented on healthy individuals to find out how they affected their static coordination ability, 7 different exercises were used for 6 weeks. After the mentioned time period, the variables obtained were combined and defined by the dependant of the variable X’s center of pressure average speed vs variable Y’s center of pressure average speed, which results showed it was clear that a difference between center of pressure average speed, before and after the exercises were performed. It can be translated into the effectiveness of the exercises based on the PNF’s pattern.

Also, Bae et al. claimed balance ability in hemiplegia patients were improved(18), while Gong et al. claimed that the contract relax exercises were applied on both healthy men and women over 20, their static coordination ability improved(19). Also Lee et al. claimed that stretch bands based on PNF’s lower-body pattern did improve older persons’ balance ability after training(20). Jansson and Soderlund conducted a study in which for 6 weeks they had 3 middle-aged women performing exercising that could be done at home, those which are said to have improved considerably their balancing abilities(21).

In the study by Yang et al., stating falls in older persons caused by weakened muscles and decreased balance ability can be prevented with strengthening muscle exercises(22). Means et al. proved falls or damage from falls can be prevented through a 6 weeks training consisting of stretching, balancing, endurance, training coordination, muscular strengthening(23). Also Kim proved improvement in balancing abilities after an implementation of home training program (24). Buchner et al. reported an increased balance ability in 106 older persons among the age of 68–85, after they were exposed to 3 times per week exercisesession for 3 months, since it can be performed at any time, this exercise has the advantage of being convenient and any place and easy to follow(25). Jo et al. suggested that the exercises are safe and easy to follow continued motion, so it is possible that they practiced hospitals and home for preventing a additional falls(26).

However, the present study it’s based on only 20 persons and has been conducted on a period of 6 weeks on healthy individuals, which can be considered a minimal training period, considering the fact that the subjects in study are healthy can be a limitation to be utilized as a practical factor to directly relate to be used to assist the older patients. Also, it’s needed to approach the PNF in various ways in order to find methods to assist older patients. This thesis will be the basis of future clinical research and be continually conducted.
CONCLUSION

This study was to investigate the effects of PNP (proprioceptive neuromuscular facilitation) pattern exercise on the static balance ability in normal young adults. Subjects are 20 normal young adult. Experimental procedure is for 6 weeks, 3 times a week, 5 minutes in a day with dance music. Apparatus is the Good Balance System, Ver 3.06 (METTUR, USA), and we got the result that compare pre-exercise single leg standing ability to post-exercise single leg standing ability.

1. In static balance ability, the usage of PNF rhythmic dance, the one leg stance, measuring the variables before and after the exercises, 'X' 'Y' variables speed, the comparison of the speed change at moment, the diminution was seen in all areas statistically meaning it brought favorable results (p<0.05).

2. In static balance ability, the usage of PNF rhythmic dance, the left one leg stance, measuring the variables before and after the exercises, 'X' variables speed, the comparison of the speed change at moment, mean X speed difference of 7.72±12.36mm/s showing a noticeable decrease.

3. In static balance ability, the usage of PNF rhythmic dance, the left one leg stance, measuring the variables before and after the exercises, 'Y' variables speed, the comparison of the speed change at moment, mean Y speed difference of 12.84±19.18mm/s showing a noticeable decrease.

4. In static balance ability, the usage of PNF rhythmic dance, the right one leg stance, measuring the variables before and after the exercises, 'X' variables speed, the comparison of the speed change at moment, mean X speed difference of 7.85±9.87mm/s showing a noticeable decrease.

5. In static balance ability, the usage of PNF rhythmic dance, the right one leg stance, measuring the variables before and after the exercises, 'Y' variables speed, the comparison of the speed change at moment, mean Y speed difference of 10.42±12.26mm/s showing a noticeable decrease.

6. In static balance ability, the usage of PNF rhythmic dance, the left one leg stance, measuring the variables before and after the exercises, left velocity moment, the comparison of the 197.86±253.18mm/s showing a noticeable decrease.

7. In static balance ability, the usage of PNF rhythmic dance, the right one leg stance, measuring the variables before and after the exercises, right velocity moment, the comparison of the speed change at moment, right velocity moment difference of 143.53±180.49mm/s showing a noticeable decrease.

This study designed that measure change of static balance in young applied by PNF rhythmic dance. The result showed that speed of X, Y direction and COP (center of pressure) velocity moment decreased after rhythmic dance. Results from this study indicated that PNF rhythmic dance has improved the static balance ability. It is good point that this program is easy, simple and wide. It is able to improve balance ability and prevent falling in elderly people. This study hoped that exercise program continued an additional study for falling prevention.

REFERENCES


24. Kim HS. Effects of home exercise program on the improvement of muscle strength, balance and gait in the elderly, Keimyung University; 2001.
