Effect of proprioceptive neuromuscular facilitation (PNF) on standing balance control among post stroke patients

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Abstract. Stroke is a neurological deficit that result of brain malfunction. Approximately 10% of post-stroke patients have coordination disorders while sitting, standing and walking. This coordination disorder is caused by several factors such as muscle tone, motoric, sensory, perception, balance, motion pattern, and associative reactions. Coordination disorder in post-stroke patients can be treated with Proprioceptive Neuromuscular Facilitation (PNF). PNF is a method of exercise therapy that aims to facilitate the neuromuscular system by stimulating proprioceptive which in the end will be achieved coordinated ability or movement. This study aim was to determine the difference between the coordination level of the PNF exercise frequency given in post-stroke patients. This research is quasi experimental with research design two group pretest-posttest time design. The sample was 20 people with 6x and 12x PNF exercise frequency. Main measure that used is a non-equilibrium coordination test pre and post PNF exercise. The result showed Mann Whitney U test was obtained p value of 0.006 (P<0.05) which there were differences between PNF exercise frequency given in post-stroke patients.

1. Introduction
Stroke is main cause of physical and disability in adults and still major cause of death in most countries [1,2,3]. Approximately, 2 million of people suffering the stroke in every year and estimation of 70%-80% of stroke patients are dependency because of disability [4]. In additions, World Health Organization (WHO) estimated 6.2 million mortality on the stroke each year, while 100,050 death due to stroke and leading to second death cause in Brazil for year 2013 [5]. In 2014, stroke is fourth cause of mortality and disability and stroke patients increases with incidence of 352.3 per 100,000 population in Thailand [6].

The stroke patients are easily to fall down due to balance dysfunction which affected the daily life activities such as walking [4,7]. The falls lead to impairment in social interaction, less self confidence and lack on the daily activity participation and contributing decreases in functional activity and dependence [8]. The balance dysfunction include instability of postural and sway, decreasing in walking speed, hemiplegic gate pattern and decrease in weight shift to the affected leg [9]. In additions, 60% of stroke patients have disabilities in the arm or leg and one-third need to stay in the nursing home or tools dependency for the independent life [10].

Proprioceptive Neuromuscular Facilitation (PNF) is stretching method utilized to improve the muscle elasticity and proved to have positive influence on the passive and active motion ranges [11].
Natarajan et al. (2008) mentioned PNF is effectively used to facilitate the movement in post stroke patients [12].

2. Methodology
The study was conducted at Asyifa clinic and Physio Sakti clinic Makassar. The study was an experimental study with pretest-posttest research design. The study population was all stroke patients who seeking treatment at Asyifa clinic and Physio Sakti clinic Makassar. The samples were 20 post stroke patients who met the inclusion criteria included be stroke patient (diagnosed by neurologist), suffered balance disturbance with using Berg Balance Scale (BBS) parameter, attend 12 times of physiotherapy and willing to be respondents.

The data was collected through primary data which obtained from patient medical record. The balance-standing ability was measured using 2 times of BBS which measured before being given of PNF exercises and after being given of 12 times of PNF exercises. The post stroke patient standing balance was categorized into 3 categories such as lower fall risk, medium fall risk and high falling risk. The data was analysed with Wilcoxon test by using SPSS program. The Wilcoxon test was conducted to determine the effect of PNF exercises toward standing balance ability in post stroke patients. The data was presented in the tables and narratives form.

3. Result and Discussion

3.1. Result

Based on Table 1, there were 9 respondents (45%) aged between 51 years and 60 years and only 1 respondent was aged between 31 years and 40 years. Meanwhile, 10 male respondents (50%) and 10 female respondents (50%) had involved in this study.

| Characteristic | N  | %  |
|----------------|----|----|
| Age (years old)|    |    |
| 31-40          | 1  |  5 |
| 41-50          | 6  | 30 |
| 51-60          | 9  | 45 |
| 61-70          | 4  | 20 |
| Total          | 20 | 100|

| Gender         | N  | %  |
|----------------|----|----|
| Male           | 10 | 50 |
| Female         | 10 | 50 |
| Total          | 20 | 100|

In additions, 5 respondents (25%) was low falling risk in standing balance abilities on pretest while 10 respondents (50%) had low falling risk in standing balance risk. There were 15 respondents (75%) had medium falling risk in pretest and 10 respondents (50%) had medium falling risk in standing balance risk during posttest. No respondent had high falling risk in standing balance abilities during pretest and post-test.

| Standing balance abilities | Low falling risk | Medium falling risk | High falling risk |
|----------------------------|------------------|---------------------|-------------------|
| N                          | %                | N                   | %                 | N                 | %                 |

Table 1. Respondent characteristic distribution.
The statistical test showed there was influence between 12 times of PNF exercises toward the standing balance abilities ($p=0.025<0.05$). In pretest, the minimum and maximum were 22 and 45 with median of 32. Furthermore, minimum and maximum of posttest were 33 and 49 with median of 41.

**Table 3.** Influence of 12 times of PNF exercise toward standing balance ability.

| BBS     | Minimum | Maximum | Median | Sig (P)* |
|---------|---------|---------|--------|----------|
| Pretest | 22      | 45      | 32.00  | 0.025    |
| Posttest| 33      | 49      | 41.00  |          |

3.2. Discussion

The study found highest number of stroke incidence found in respondents aged between 51 years and 60 years old. The risk factors of non-modifiable stroke was related to aging process and modifiable risk factors such as hypertension, cardiovascular diseases and diabetes mellitus. Furthermore, 10 male respondents and 10 female respondents which gender was not correlated with the stroke incidence.

In this study, 12 times of PNF exercises had significant influence toward the standing balance ability in post stroke patients. Tung et al. (2010) found 12 times of PNF exercises had improved balance and muscle strength for stroke patients [13]. Various exercises like special movement exercises such as stimulus and PNF exercise, Bridging exercise, core stability and other methods to activate brain memory. Brain activation is possible because the brain has very special character that brain is easy to adapt even if the brain neurons was died without regeneration. The ability of neuroplasticity in the brain allows certain brain parts to take over the function of brain damaged parts.

The stroke were associated with the recovery limitation of the brain function. Although, the peri-infarct area became more neuroplastic that improved the sensory function of remodeling in the brain damaged area. The balance effect on the post stroke patient is due to the exercise, while PNF was more geared towards movement with diagonal and spiral patterns that suitable with movement used in daily activities. The approach model used was approach based on functional nature. Neuroplasticity occurred through the synapse latent effectiveness, increased in nerve sensitivity and Akron regeneration.

Victoria et al. (2013) mentioned PNF exercises helped in muscle strength and endurance development, joint stability, balance, mobility, neuromuscular control and coordination which aimed to improve overall stroke functional ability since PNF exercise occurred due strengthening and functional movement that occurred simultaneously [14].

Most important part is proprioception which maintained the balance. Some sensory receptor types throughout the skin, muscles, joint and ligaments provided the body ability to recognize both internal and external environment changes on each joint and ultimately influenced balance improvement. The body balance is influenced by sensory system found in the human body working simultaneously if any system is disturbed, there would be imbalance in the body, sensory system that regulated or control the balance such as visual, vestibular and somatosensory (tactile and proprioceptive).

The occurrence of motor repair changes such as increased muscle strength and walking ability in post stroke patient is not separated from brain ability able to make structural and functional changes (plasticity) during given stimulation. Sensory stimulation is experience and action response (sensorimotor). The information entered and received short-term memory is only biological phenomenon which lasts several minutes until hours. The learning success occurs when information is transferred to the long term memory. The information transfers could complete through exercise,
repetition, attention and association strategies. Long term memory changed the brain structure with gene activity, new protein formation and neuron branch cell growth.

4. Conclusion
In conclusion, there was influenced of 12 times of PNF exercises toward the standing balance ability in post stroke patients. The physiotherapist in the hospital or clinic can choose the modality of PNF exercise as one modality to improve the standing balance ability of post stroke patients.

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