

# Effect of Eye Movement with PNF Neck Movement on Balance and Functional Mobility in Subacute Stroke Patients

Shweta Thorawade<sup>1</sup>, Chintan Solankhi<sup>1</sup>

<sup>1</sup>Department of Neurosciences, College of Physiotherapy, Wanless Hospital, MUHS University, Miraj, India.

Corresponding Author: Shweta Thorawade

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## ABSTRACT

**BACKGROUND:** Stroke is the leading cause of disability in adults and third leading cause of death. Individuals with stroke experience balance issues that limit their ability to perform a variety of daily tasks. Stroke patients have impaired oculogyration (Eye movement) and have trouble moving their eyes which is a barrier to improve functional capacity. Oculogyration (Eye Movement) was found to be useful in stroke patients to improve balance. PNF enhances muscle functioning via enhancing proprioceptive sensibility, strength, flexibility and balance is improved. Subacute phase of stroke lasts for 7 days to 3 months during which majority of changes happen, very few studies have seen the effect of eye movement with PNF neck movement on balance and functional mobility in this population so this study aimed to find out the effect of eye movement with PNF neck movement on balance and functional mobility in patients with subacute phase of stroke.

**PURPOSE:** To evaluate the effects of eye movement with PNF neck movement on balance and functional mobility in subacute phase of stroke patients.

**METHODOLOGY:** A total of 38 subjects was divided into two groups according to inclusion, exclusion criteria. Pre intervention assessment was done using Berg balance scale and timed up and go test. Experimental group was given eye movement with PNF Neck movement along with conventional exercises. Control group performed conventional treatment. The protocol was given for 60 min. for 3 times weekly for 8 weeks for both the groups.

**RESULTS:** Statistical Analysis was done using paired t test. Based on the results of the test analysis at 5% significance level, there is a significant statistical reliable difference between the pre and post treatment values with p-value less than the 5% significance level ( $< 0.05$ ) in study and therefore it justifies the improvement in health outcome post intervention.

**CONCLUSION:** The present study concluded that oculogyration (Eye Movement) and neck movement by PNF proved to be beneficial for improving balance and functional mobility of subacute stroke patients.

**Keywords:** Balance, eye movements, Functional mobility, PNF neck movement, Subacute

## INTRODUCTION

Stroke is described by the World Health Organisation as "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or longer or resulting in death."<sup>1</sup> A stroke is a condition that impairs the brain by rupturing the blood vessels that supply it

with oxygen and nutrients or by obstructing the blood arteries with blood clots<sup>2</sup>

Stroke is the third-leading cause of death and the main contributor to adult disability in developed nations.<sup>3</sup> Additionally, stroke is one of the top three killers, resulting in 150,000 fatalities annually.<sup>1</sup> At any given moment, there are about 3 million stroke

survivors.<sup>1</sup> A stroke's estimated adjusted prevalence rate in India is between 84 and 262 per 100,000 in rural areas and 334 to 424 per 100,000 in urban areas.<sup>1</sup> According to recent population-based studies, the incidence rate ranges from 119 to 145/100,000<sup>4</sup>. Case fatality rates also vary greatly, with Kolkata having the highest rate at 42%.<sup>4</sup>

Sudden numbness or weakness of the face, arm, or leg, especially on one side, sudden confusion or difficulty speaking, sudden difficulty seeing with one or both eyes, sudden difficulty walking, dizziness, or loss of balance, and a sudden, severe headache with no apparent cause are all indications of a stroke<sup>5</sup>.

In the subacute phase, more than 80% of people who have had a first time stroke, experience balance problem<sup>7</sup>. Reduced balance and postural control are associated with an increased risk of falls and mobility disability in stroke patients, which makes them incapable and dependent in daily activities<sup>7</sup>. People who have had a stroke have frequently shown to have higher postural sway than age-matched healthy volunteers in tests of balance impairments<sup>8</sup>. Individuals who had a cerebrovascular accident, experience balance issues that limit their ability to perform a variety of daily tasks<sup>9</sup>

The majority of stroke survivors have ongoing trouble completing daily tasks<sup>10</sup>. A decline in functional mobility, which relates to the capacity to transfer (for example, getting in and out of a bed or chair), walk a specific distance and turn, and is connected with preserving independence, is a commonly recognised residual deficit following a stroke<sup>10</sup>. Patients who have suffered a stroke have a considerable deterioration in quality of life due to social isolation and inactivity as a result of reduced functional mobility<sup>10</sup>. This could result in a greater rate of morbidity and mortality<sup>10</sup>. It has been demonstrated that growing older, inactivity, and cognitive impairment are predictors of functional mobility loss<sup>10</sup>.

The majority of stroke victims have ongoing trouble doing daily tasks. Stroke survivors with limited motor function plan reaching actions with several saccades (rapid eye movements)<sup>11</sup>. On the other hand, stroke patients' impaired eye movements and difficulty moving their eyes in a pendulum motion are considered as obstacles to enhancing functional capacity and movement therapy<sup>2</sup>. Number of methods have been used to help stroke victims regain their balance, and in recent years, visual movement intervention tactics have gained popularity<sup>2</sup>. It has been shown that eye movements, or oculogyrations, can assist stroke victims restore their balance<sup>2</sup>. The direction of the head and eyes also affects how people stand<sup>2</sup>. The subject's oculogyration (eye movement) increases their standing capacity by activating their vestibular and visual systems<sup>2</sup>. Several studies have shown that visual search and eye movement training improves performance in sporting and occupational activities in healthy adults as well as in clinical populations this suggests that therapies aimed at improving visual search in stroke survivors may result in improved functional outcomes.<sup>11</sup>

However, a study of neck movement which together with oculogyration (Eye Movement) plays a significant part in standing posture control<sup>2</sup>.

Patients who have had strokes have less ability to balance due to their weak trunk muscles<sup>12</sup>. A muscle reaction may be influenced by traction, stretch reflex, radiation, resistance, and other proprioceptive input<sup>12</sup>. PNF combines procedures and overlaid techniques that cause muscular contraction, relaxation, and muscle strength with the use of spiral and diagonal pattern specific motions (with antagonist and agonist muscles)<sup>12</sup>. PNF uses physical assessment and treatment of the neuromuscular skeletal system to apply neurophysiological principles of the sensory/motor system<sup>12</sup>. PNF gives the therapist a useful tool for diagnosing and treating structural and neuromuscular

dysfunctions<sup>12</sup>. The facilitation, inhibition, strengthening, and relaxation of muscular groups through the use of concentric, eccentric, and static muscle contractions are the main objectives of PNF approaches. Muscles are improved by proprioceptive neuromuscular facilitation<sup>12</sup>.

Input from neck muscles' proprioceptive afferents is crucial for posture regulation. The neck muscles are crucial for good posture and efficient walking<sup>2</sup>. and sustaining posture is aided by the receptors found in the muscles of the neck<sup>2</sup>. Compared to other body muscles, such as the tiny muscles in the hands or eyes, the neck muscles have an exceptionally high proprioception sense<sup>2</sup>. It is thought that, as in this study, the increased trunk stability is caused by the increased proprioceptive sense input by the movement, in various directions, with the proprioceptive movement of the neck, which ultimately increases balance<sup>2</sup>. Changes in the neck position of the stroke patient are associated with changes in posture control<sup>2</sup>.

The majority of alterations occur during the subacute phase of stroke, which lasts for 3 to 11 weeks<sup>15</sup>. A crucial period for brain plasticity occurs from the first week to the first month<sup>15</sup>. The first three months after a stroke are when most motor and functional recovery takes place<sup>15</sup>. Therefore, this investigation must be carried out during the subacute period of a stroke<sup>15</sup>.

The berg balance scale can assess a patient's capacity to carry out a task or action because it is a functional outcome measure in the international classification of functioning domain of activity<sup>13</sup>. The berg balance scale evaluates balance. The berg balance scale is a viable and reliable tool for evaluating balance and functional mobility in the post stroke population<sup>13</sup>.

The timed up and go test is valid, accurate and simple to use clinical test for evaluating advanced functional mobility following a stroke<sup>14</sup>.

**AIM-** To find out the effect of eye movement with Proprioceptive

neuromuscular facilitation (PNF) neck movement on balance and functional mobility in subacute stroke patient

**OBJECTIVES-** To study the effect of eye movement with Proprioceptive neuromuscular facilitation (PNF) neck movement on balance in subacute phase of stroke patients using Berg balance scale. To study the effect of eye movement with Proprioceptive neuromuscular facilitation (PNF) neck movement on functional mobility in subacute phase of stroke patients using Timed up and go test.

## LITERATURE REVIEW

### 1. Dong Hoon Kim et al (2019)

Purpose of the study was to evaluate Effects of eye movement with PNF neck movement on trunk stability and standing position balance ability of chronic stroke patients. A total of 30 patients were randomly divided into exp.group and con. Group exp. Group was performed 60 min. three times a week for 8 weeks in eye movement and PNF neck movement .Con. group performed conservative treatment for 60 min.Outcome measures were used are TIS,BBS and FRT which resulted in Oculogyration and neck movement by PNF have positive effects on the trunk stability and standing position balance ability of chronic stroke patients

### 2. Mohammad Y.Elhamrawy et al (2019)

Purpose of the study was to find out on effect of eye movement training on balance in elderly post stroke patients with unilateral spatial neglect. The study included 15 subjects and received sequentially in same session training for eye movement program and traditional gait training .assessment was done by BBS,TUG ,10Mwt, 6 mwt by program 4 days per week for 6 weeks which suggested that in eye movement training improved patients with unilateral spatial neglect ability to explore the blind hemisphere and improve balance.

### 3. Megan kudlac et al (2019)

Aim of the study was to assemble literature on the reliability and validity of the berg balance scale to determine its suitability as a clinical tool in patients with post stroke .

### 4. Aditi Chaturvedi (2017)

The purpose of this study is to review the effectiveness of PNF In stroke for functional recovery of patients, this finding provides Important aspects regarding the use of PNF In functional recovery of Stroke, in various functional activities According to ICF corsets as PNF helps in Major areas like gait, coordination and balance.

### 5. Sandra Jackson et al (2017)

Purpose of the study on sociodemographic and geographic variation in awareness of stroke signs and symptoms among adults which resulted in ,only two third of adults surveyed had the combination of stroke knowledge and geographic variation and sociodemographic disparities remain.

### 6. Peggy Pkchan et al (2017)

The purpose of the study was to examine the reliabilities of the timed up and go test.for people with chronic stroke 33 stroke survivors and 32 healthy older adults were included outcome measures used are FMA-LE BBS and FTSTS.

### 7. SI-EUN PARK et al (2016)

Purpose of the study was to assess the Effect of eye movements and proprioceptive neuromuscular facilitation on balance and head alignment in stroke patients with neglect syndrome the study was conducted on 20 subjects and were randomly allocated to two groups the eye movement group and PNF with eye movement group .The program was conducted 5 times each week for 6 weeks which resulted in for neglect patients PNF training with eye movement is more effective than eye movements alone.

### 8. Neo HwaNG-BU et al (2016)

The purpose of this study was to investigate the effects of PNF neck pattern exercise on the ability to control the trunk and maintain balance in chronic stroke patients.A total of 30 study subjects were selected and randomly divided into an experimental group of 15 subjects who received the PNF neck pattern exercises and a control group of 15 subjects who received a traditional rehabilitation treatment. outcome measures used were TIS,BBS. which resulted in the PNF neck pattern exercise was shown to have a positive effect on increasing ability to control the trunk and maintain balance in chronic stroke patients.

## MATERIALS & METHODS

### METHODOLOGY

#### MATERIALS

Drawing board of eye movement, Chair, Tape, Stopwatch



Figure 1- chair



Figure. 2 – eye movement board



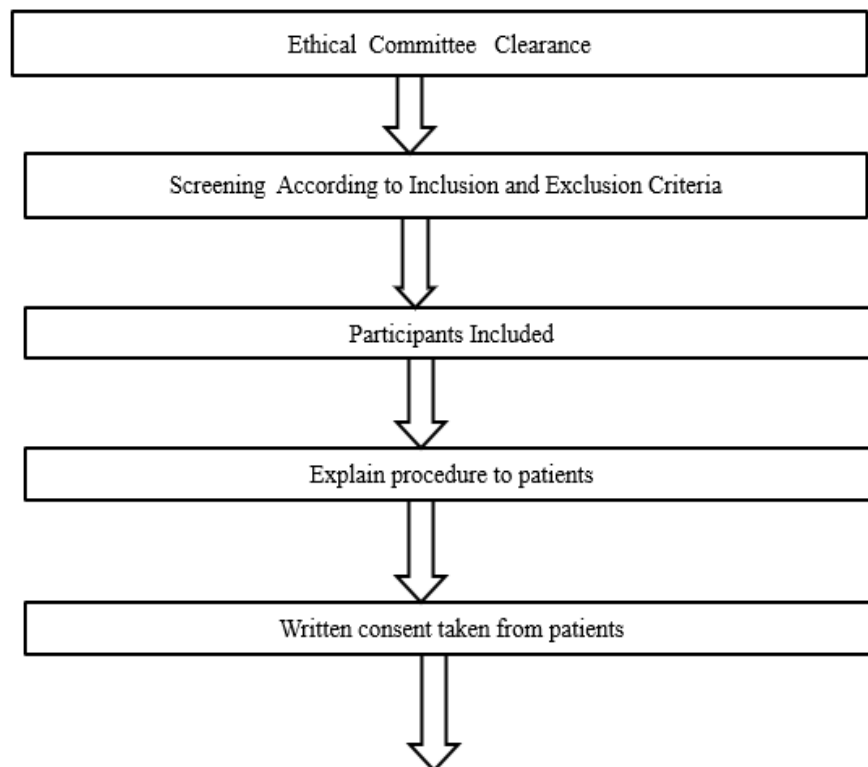
Figure.3 –Tape

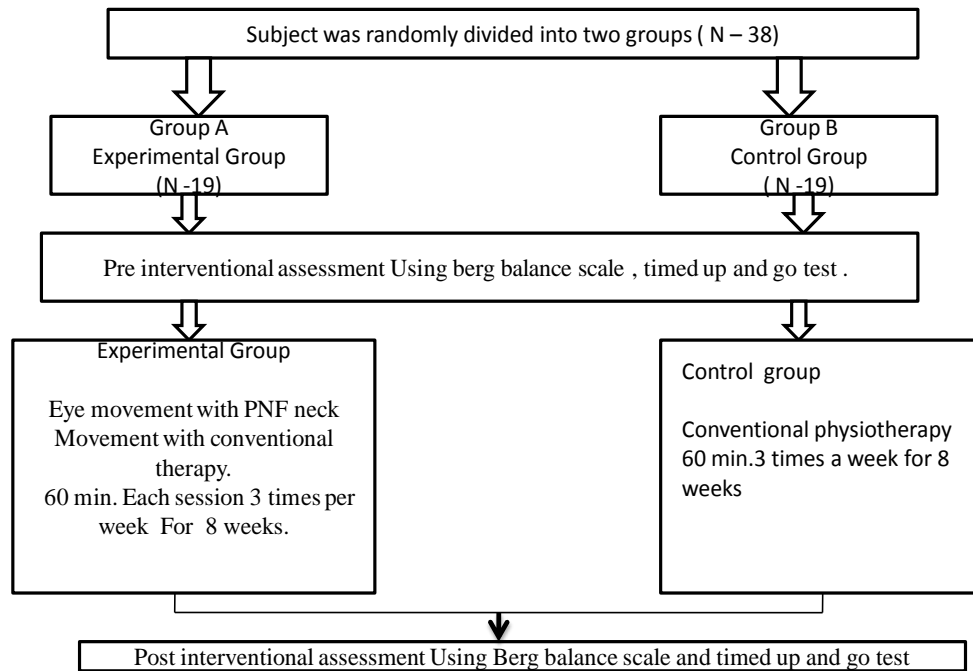


figure 4 - stopwatch

- STUDY TYPE: An Experimental study
- SAMPLING DESIGN: Simple random sampling
- SAMPLE SIZE:38
- STUDY POPULATION: subacute stroke patients.
- STUDY DURATION: 6 months
- STUDY SETTING: Neuro hospitals in Sangli district.

#### Procedure





## PROTOCOL

- Oculogyration (Eye Movement) exercise program included three stages:
  - Saccadic eye movement-Up and down or right and left movement of the eyeball.
  - Pursuit eye movement-Diagonal eye movement.
  - Vergence eye movement-moving the target slowly from 10 cm to 50cm proximal to distal and distal to proximal.

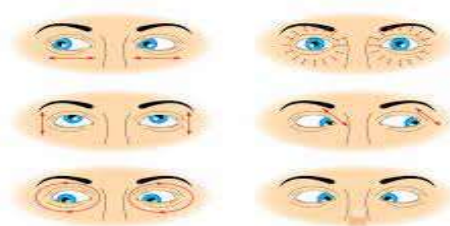


Figure 5 – Eye movements

Each movement 10 times 2 sets of exercise program followed by a warm down exercise.

Warm down exercise –to provide rest to the eyeballs by rubbing both hands to make them warm and then covering the subjects eyes lightly with their palm.



Figure 2

## PNF neck movement using combination of isotonic technique.

- Combination of isotonic technique – combined concentric eccentric and stabilizing contractions of one group of muscles without relaxation.
  - The therapist resists the patients moving actively through a desired ROM (concentric contraction)
  - At the end of ROM the therapist tell the patient to stay in that position. (stabilizing contraction)
  - When stability is attained therapist tells the patient to allow the part to be moved slowly back to the starting position (eccentric contraction)

4. There is no relaxation between the different types of muscle activities. Each pattern =10 times 3sets

**Neck movement pattern consist of**

**1. Extension/ right lateral flexion/right rotation-**

- Patient position-sitting
- Therapist position –Stand behind subject at the right side.
- Grips – right thumb on the middle of the patients chin left hand over top of head of patient. Resistance is given by right hand over the chin.

**2. Extension/left lateral flexion/left rotation-**

- Patient position –sitting
- Therapist position-Stand behind the patient.
- Grip –left thumb on the middle of patient’s chin. Right hand over the top

of head of patient. Resistance is given by left hand

**3. Flexion/left lateral flexion/left rotation-**

- Patient position –sitting
- Therapist position-Stand behind the patient.
- Grip –fingertips of right hand under patient’s chin. Hold the top of head with left hand. Resistance is given with right hand.

**4. Flexion /right lateral flexion/right rotation-**

- Patient position – sitting
- Therapist position-stand behind the patient
- Grip –fingertips of left hand under the patient’s chin. Hold the top of head with right hand. Resistance is given left hand.

Figure 6- Proprioceptive neck movement exercise



**Conventional Physical therapy- 3 sessions of 60 min per week for 8 consecutive weeks.**

- Bed mobility
- Sitting balance –LE uncrossed to crossed, sitting on a mat to sitting on a therapy ball, sitting eyes open to eyes closed on a therapy ball

UE- UE extended to UE folded across chest, single UE raises, bilateral UE raises, reaching movements with emphasis on affected side, picking objects off table, stool or floor.

- Standing- single leg support, stepping forward and backward, sideways, step-ups, marching in place, foot on ball, moving a ball with LE.
- Trunk movements – head and trunk rotations, looking up at ceiling and down to floor
- Stretching

3 sets of 10 reps each with 10 seconds hold each

- Functional activities- sit to stand, sit down, turning arounds, floor to standing, lunges, walking activities – forward,

backward, sideward, cross-step walking and obstacle stepping.

**CONTROL GROUP:**

Conventional therapy alone.

**STATISTICAL ANALYSIS**

Data Analysis was performed using statistical package for the social sciences (SPSS) software.

Comparison of pre test and post test scores of BBS in group A and B by Paired sample t test

Comparison of pre test and post test scores of TUG in group A and B by Paired sample t test.

Between groups A and B independent test for group statistics By using independent t test

**RESULT**

Statistical analysis was done using paired t test and independent t test.

Normality test using Shapiro-Wilk

Variable	Time frame	Group EXP		Group CNT	
		z-value	p-value	z-value	p-value
BBS	Pre	0.931	0.180	0.967	0.712
	Post	0.968	0.728	0.937	0.233
	Diff	0.905	0.061	0.891	0.051
TUG	Pre	0.958	0.530	0.961	0.599
	Post	0.962	0.612	0.947	0.356
	Diff	0.921	0.118	0.866	0.012

Data set is normally distributed as all the variables have indicated non-significant outcome in the observation. The researcher shall use parametric test for data analysis purpose in the following sections.

**Demographic information**

Table no. 1:

Particular	Group		Total	
	Group EXP	Group CNT		
Gender	Male	11	12	23
	Female	8	7	15
Total	19	19	38	

Graph no. 1:

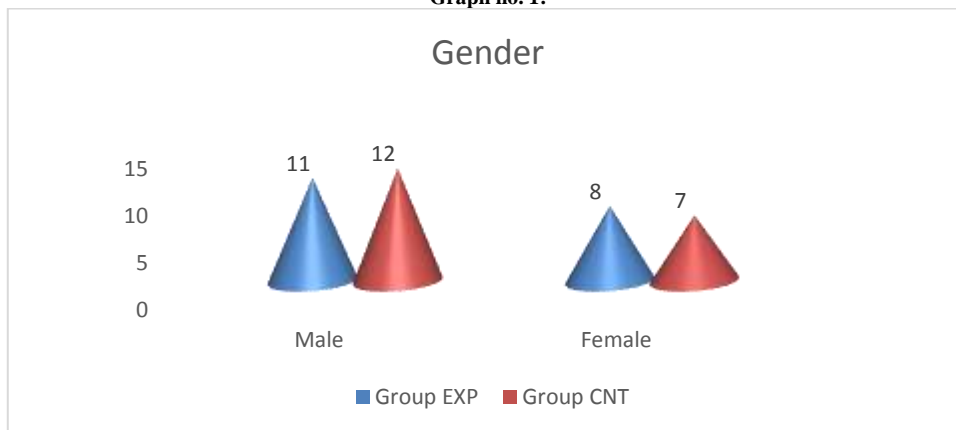


Table no. 2:

Descriptive statistics:

Variable	Groups	Mean	SD	t-value	p-value
Age	Group EXP	53.68	7.04	0.953	0.347
	Group CNT	55.79	6.56		

**Independent sample test**

Comparison of Groups with mean age by independent t test

**Graph no 2:**

Table no. 3:

**Within group Pre and post test**

Comparison of pre-test and post-test scores of BBS in two Groups by paired sample t test.



Groups	Times	Mean	SD	Mean Diff.	SD Diff.	Effect size	t-value	p-value
EXP	Pre	32.58	2.73	4.53	1.47	3.09	13.449	0.001*
	Post	37.11	2.69					
CNT	Pre	33.26	2.66	2.00	0.67	3.00	13.077	0.001*
	Post	35.26	2.92					

The effect size or Cohen’s D indicates 3.09 value which is assumed to be very high in effect size as per the standard parameters of reference. Based on the results of the test analysis at 5% significance level, there is a significant statistical reliable difference between the pre & post treatment values with p-value is less than the 5% significance level (i.e. 0.001 < 0.05) in the study and therefore it justifies the improvements in health outcome post intervention.

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effect size as per the standard parameters of reference. Based on the results of the test analysis at 5% significance level, there is a significant statistical reliable difference between the pre & post treatment values with p-value is less than the 5% significance level (i.e. 0.001 < 0.05) in the study and therefore it justifies the improvements in health outcome post intervention.

### Graph no. 3

**Table no.4: Comparison of pre-test and post-test scores of TUG in two Groups by paired sample t test**

Groups	Times	Mean	SD	Mean Diff.	SD Diff.	Effect size	t-value	p-value
EXP	Pre	25.37	2.63	3.89	1.45	2.69	11.717	0.001*
	Post	21.47	2.55					
CNT	Pre	26.47	2.89	2.21	0.92	2.41	10.500	0.001*
	Post	24.26	3.00					

The effect size or Cohen’s D indicates 2.69 value which is assumed to be very high in effect size as per the standard parameters of reference. Based on the results of the test analysis at 5% significance level, there is a significant statistical reliable difference between the pre & post treatment values with p-value is less than the 5% significance level (i.e. 0.001 < 0.05) in the study and therefore it justifies the improvements in health outcome post intervention.

The effect size or Cohen’s D indicates 2.41 value which is assumed to be very high in effect size as per the standard parameters of reference. Based on the results of the test analysis at 5% significance level, there is a significant statistical reliable difference between the pre & post treatment values with p-value is less than the 5% significance level (i.e. 0.001 < 0.05) in the study and therefore it justifies the improvements in health outcome post intervention

**Graph no.4:**

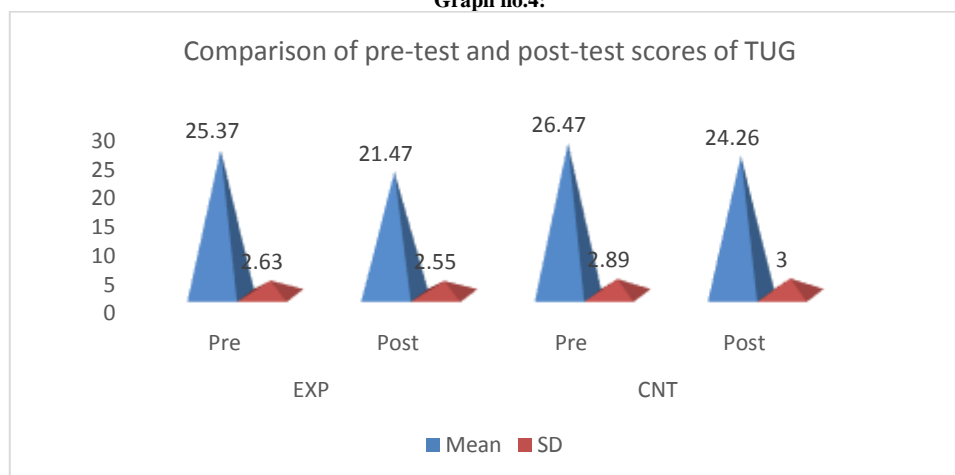
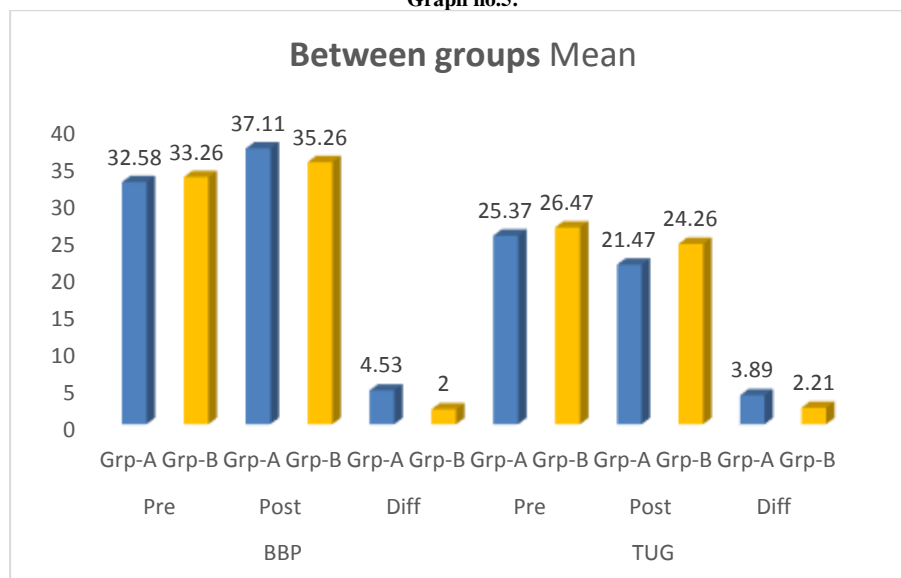


Table no. 5: Between groups independent test for Group Statistics using independent ttest

Variable	Time	Group	Mean	SD	t-value	p-value
BBS	Pre	Grp-A	32.58	2.73	0.781	0.440
		Grp-B	33.26	2.66		
	Post	Grp-A	37.11	2.69	2.023	0.050*
		Grp-B	35.26	2.92		
	Diff	Grp-A	4.53	1.47	6.834	0.001*
		Grp-B	2.00	0.67		
TUG	Pre	Grp-A	25.37	2.63	1.232	0.226
		Grp-B	26.47	2.89		
	Post	Grp-A	21.47	2.55	3.092	0.004*
		Grp-B	24.26	3.00		
	Diff	Grp-A	3.89	1.45	4.280	0.001*
		Grp-B	2.21	0.92		

From the above table it is observed that between groups analysis is significant for difference at 5% level significance as the p-value is less than 5%. It shows significant differences between the groups for both the variables

Graph no.5:



### RESULT FROM ANALYSIS

From the above within pre and post analysis of BBS score, the BBS mean value in EXP group indicated changes post treatment and higher values are recorded for post treatment outcome and also the standard deviation shows the consistency with post treatment value which is less than pre value. The BBS mean value in CNT group indicated changes post treatment and higher values are recorded for post treatment outcome and also the standard deviation shows the limited consistency with post treatment value which is more than pre value.

From the above within pre and post analysis of TUG score, The TUG mean

value in EXP group indicated changes post treatment and lower values are recorded for post treatment outcome and also the standard deviation shows the consistency with post treatment value which is less than pre value. The TUG mean value in CNT group indicated changes post treatment and lower values are recorded for post treatment outcome and also the standard deviation shows the limited consistency with post treatment value which is more than pre value

From the above it is observed that between groups analysis is significant for difference at 5% level significance as the p-value is less than 5%. It shows significant

differences between the groups for both the variables

Thus it is inferred that there is a substantial statistically significant difference between the groups across pre and post values.

Further it is observed that group A is better as higher mean is recorded as compared to group B after medical intervention.

## DISCUSSION

The purpose of this study was to find out effectiveness of eye movement with PNF neck movement on balance and functional mobility in subacute stroke patients. This study was conducted on 38 subjects out of total participants an age group of 45-65 years and were selected according to inclusion criteria and were randomly divided into two groups with each containing 19 participants. Group A consist of 11 Males and 8 females. Group B consist of 12 Males and 7 females. Baseline measurements of BBS and TUG test score were taken.

Group A received the oculogyration (Eye Movement) protocol where PNF neck movement were applied in parallel (19 subjects) and Group B a conservative treatment (19 subjects), intervention was given in 3 sessions for 8 consecutive weeks. Mean age in group A and group B was 53.68 and 55.79 Respectively. Both group showed an improvement in balance and functional mobility, and in comparison between groups, the Group A showed a further improvement in the BBS and TUG test.

In terms of the change in balance after oculogyration (Eye Movement) and neck movement by PNF, although both groups showed an improvement, the improvement in the exp. Group was increased. In this present study neck PNF using combination of isotonic technique is used to improve balance because PNF improves functions of muscles and tendon by stimulating proprioceptive sense these exercises enhances stability of head and neck. the technique used causes resistance against neck exercise eventually causing irradiation

in body increasing proprioception. also eye movements applied in this study have positive effect on balance as it induces the contraction of antigravity muscles.

There are three phases of stroke-acute phase, subacute phase and chronic phase. The Subacute phase of stroke lasts for 3 to 11 weeks during which majority of changes happen according to study done by ping wu et al. Neuroplasticity refers to brain's ability to change and adapt due to experience, Julie Bernhardt et al conducted a study and suggested that the first week to first month post stroke is a critical time for neural plasticity and should be target for recovery trials, so it is needed to conduct this study in Sub Acute phase of stroke.

Comparable to the method in our study, Dong hoon kim et al found out the effect of eye movement with PNF neck movement which proved that there is an significant improvement in balance and trunk stability, the control group was treated only with neurodevelopmental treatment and the intervention group was treated with eye movement with neck PNF in addition to neurodevelopmental treatment, as direction of eyes and head are very important for posture control and increased proprioception increases stability as neck muscles have high proprioception and play important role in maintaining posture.

There are limited number of studies that have found the relation between neck PNF with eye movement in combination on balance and functional mobility. most of the studies focus on chronic stroke population therefore our study is important as to find it out in subacute stroke population. PNF is the neurophysiological approach in which impulses from periphery are facilitated to the CNS through the stimulation of sensory receptors present in muscles and around the joints by stretch and resistance improving functions and increasing muscle strength flexibility and balance in stroke patients as reported by Marimuthu Dinesh et al, conducted a study on PNF neck pattern and trunk specific exercise which eventually improved trunk control and balance among

stroke patients . In a research on the effects of PNF technique on functional mobility and gait characteristics in hemiparetic patients s kumar et al found that PNF technique have significant effect on both of these outcomes..

70% of stroke patients will have an eye movement disorder that can impact their rehabilitation outcome and their return to independent living .Si eun park et al conducted In a study on effect of eye movements and PNF on balance and head alignment in stroke patients with neglect syndrome,si eun et al found that eye movement activated brain regions that positively impacted balance ability.

Sana batool et al conducted a study on effects of visual scanning exercises in addition to task specific approach on balance and activities of daily livings in post stroke patients with eye movement disorder resulted in improvement of balance function and as a result of balance functions ADL functions also improved.

This study suggest that a study on neck movement which together with oculogyration (Eye Movement) plays a significant part in posture regulation ,improving balance and functional mobility.

## CONCLUSION

This study concluded that oculogyration (Eye Movement) and neck movement by PNF along with conventional therapy proved to be beneficial for improving balance and functional mobility of subacute stroke patients.

### Declaration by Authors

**Ethical Approval:** Approved

**Acknowledgement:** None

**Source of Funding:** None

**Conflict of Interest:** The authors declare no conflict of interest.

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