EFFECTIVENESS OF PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION AND DUAL TASK TRAINING IN PREVENTION OF FALLS AND TO IMPROVE THE QUALITY OF LIFE AMONG CEREBELLAR STROKE INDIVIDUALS

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ABSTRACT: Cerebellar stroke is a type of posterior circulation stroke characterized by impaired coordination, balance deficits, postural instability, and reduced motor control, often leading to increased risk of falls and decreased quality of life. Proprioceptive neuromuscular facilitation (PNF) enhances balance and coordination by stimulating proprioceptors and promoting coordinated movement patterns, whereas dual task training improves cognitive-motor integration and functional mobility. This comparative study included 30 cerebellar stroke individuals aged 50–75 years who were randomly allocated into two groups. Group A (n=15) received proprioceptive neuromuscular facilitation, while Group B (n=15) received dual task training for 12 weeks. Balance was assessed using the Berg Balance Scale (BBS), and quality of life was evaluated using the WHO-Quality of Life BREF Scale. Results showed significant improvement in both groups; however, post-test comparison revealed higher mean BBS scores in Group B (46.20±1.30) than Group A (42.60±1.90) ($t=6.54$, $p<0.001$). Similarly, WHO-QOL BREF scores were significantly higher in Group B (72.80±3.10) compared to Group A (64.10±3.50) ($t=7.37$, $p<0.001$), indicating greater effectiveness of dual task training. The findings suggest that dual task training is more effective than proprioceptive neuromuscular facilitation in preventing falls and improving quality of life among cerebellar stroke individuals and can be recommended as an effective rehabilitation strategy.

KEYWORDS: Cerebellar stroke, Proprioceptive neuromuscular facilitation, Dual task training, Balance, Fall prevention, Quality of life.

INTRODUCTION:

According to the World Health Organization, stroke is defined as rapidly developed clinical signs of focal or global disturbance of cerebral function lasting more than 24 hours or leading to death, with no apparent cause other than vascular origin. The cerebellum, located in the posterior cranial fossa beneath the cerebrum and posterior to the brainstem, plays a major role in coordination, balance, posture, and motor control. It is divided into anterior, posterior, and flocculonodular lobes and functionally classified into cerebrocerebellum, spinocerebellum, and vestibulocerebellum based on their neural connections. The cerebellar cortex contains molecular, Purkinje, and granular layers that form an organized microcircuit

essential for motor learning and coordination [1,2]. The pathophysiology of cerebellar stroke involves disruption of blood supply to cerebellar tissue, resulting in ischemia, neuronal injury, and loss of motor coordination. Ischemic cerebellar stroke commonly occurs due to occlusion of the posterior inferior cerebellar artery (PICA), anterior inferior cerebellar artery (AICA), or superior cerebellar artery (SCA), while haemorrhagic stroke results from vascular rupture and bleeding into cerebellar tissue. These vascular insults impair cerebellar pathways responsible for balance and movement control, leading to ataxia, gait instability, and postural deficits. (3) At the cellular level, ischemia causes excessive glutamate release, calcium influx, oxidative stress, mitochondrial dysfunction, and neuronal apoptosis, further worsening neurological damage. Clinical manifestations of cerebellar stroke mainly include impaired coordination, truncal and limb ataxia, dysmetria, dysdiadochokinesia, vertigo, dizziness, nystagmus, dysarthria, hypotonia, and poor postural control [4]. These impairments significantly increase fall risk and reduce functional independence and quality of life. Cerebellar stroke accounts for approximately 2–3% of all stroke cases worldwide and is more common in males due to greater exposure to risk factors such as smoking, hypertension, and cardiovascular disease [5]. Major causes include atherosclerosis, cardio embolism, small vessel disease, hypertension, and vascular malformations. Risk factors are classified into modifiable factors such as hypertension, diabetes mellitus, obesity, smoking, alcohol consumption, and physical inactivity, and non-modifiable factors including age, gender, genetic predisposition, and previous cardiovascular disease.

The Berg Balance Scale (BBS) is a reliable and valid assessment tool used to evaluate static and dynamic balance and predict fall risk in stroke patients. The WHO-Quality of Life BREF Scale is widely used to assess quality of life across physical, psychological, social, and environmental domains. Cerebellar stroke-related balance impairments and gait instability greatly affect these domains, leading to decreased independence and social participation. Proprioceptive Neuromuscular Facilitation (PNF) is an effective neurorehabilitation approach that improves balance, coordination, and functional mobility by enhancing proprioceptive feedback and sensory-motor integration[1].It utilizes diagonal movement patterns and techniques such as rhythmic stabilization, slow reversal, and hold-relax to improve joint stability and postural control[2].Dual task training is another rehabilitation strategy that combines motor and cognitive activities simultaneously to improve balance and attentional control during functional activities[3].This approach enhances cognitive-motor integration, gait stability, and automaticity of movement by promoting neuroplasticity and strengthening neural coordination pathways[4].Both interventions are beneficial in reducing fall risk and improving functional independence in cerebellar stroke individuals[5].Therefore, the present study aims to evaluate the effectiveness of proprioceptive neuromuscular facilitation and dual task training in preventing falls and improving the quality of life among cerebellar stroke individuals[6].

AIM OF THE STUDY:

The aim of the study is to assess the effectiveness of Proprioceptive Neuromuscular Facilitation and Dual task training in prevention of falls and to improve the quality of life among cerebellar stroke individuals.

OBJECTIVES OF THE STUDY:

- To evaluate the effects of proprioceptive neuromuscular facilitation in prevention of falls and to improve the quality of life among cerebellar stroke individuals.
- To evaluate the effects of dual task training in prevention of falls and to improve the quality of life among cerebellar stroke individuals.
- To compare the effects of proprioceptive neuromuscular facilitation and dual task training in prevention of falls and to improve the quality of life among cerebellar stroke individuals.

BACKGROUND OF THE STUDY:

Cerebellar stroke is a neurological condition caused by interruption of blood supply to the cerebellum due to ischemia or haemorrhage. Since the cerebellum controls balance, coordination, posture, and motor control, affected individuals commonly experience ataxia, dizziness, vertigo, and unsteady gait, leading to impaired mobility and increased fall risk. Proprioceptive Neuromuscular Facilitation (PNF) significantly improves balance, gait, trunk stability, and postural control in cerebellar stroke patients, thereby reducing fall risk and enhancing functional mobility. Dual-task training improves gait, balance, and functional mobility by reducing cognitive-motor interference and enhancing independence in daily activities, ultimately lowering fall risk. Proprioceptive Neuromuscular Facilitation (PNF) significantly improves balance, gait, trunk stability, and postural control in cerebellar stroke patients, thereby reducing fall risk and enhancing functional mobility**.**

NEED OF THE STUDY:

Cerebellar stroke individuals commonly present with impaired balance, coordination deficits, and postural instability, which significantly increase the risk of falls and negatively impact their quality of life. Conventional physiotherapy rehabilitation mainly focuses on basic motor recovery but often fails to address dynamic balance and real-life functional challenges. Proprioceptive Neuromuscular Facilitation (PNF) has been shown to improve neuromuscular coordination and trunk stability, whereas dual task training enhances cognitive-motor integration required for daily activities.. Therefore, this study is needed to evaluate and compare the effectiveness of Proprioceptive neuromuscular facilitation and dual task training in reducing fall risk and improving quality of life among cerebellar stroke individuals

HYPOTHESIS:

NULL HYPOTHESIS:

There is no significant difference between the effectiveness of proprioceptive neuromuscular facilitation and dual task training in prevention of falls and to improve the quality of life among cerebellar stroke individuals.

ALTERNATE HYPOTHESIS:

There is a significant difference between the effectiveness of proprioceptive neuromuscular facilitation and dual task training in prevention of falls and to improve the quality of life among cerebellar stroke individuals.

REVIEW OF LITERATURE:

1.**Pathania V et al., (2025)** Effect of proprioceptive neuromuscular facilitation pattern on balance and gait in post-stroke patients, this study concluded that PNF training improves balance and gait in stroke patients, enhances neuromuscular coordination, and is useful in stroke rehabilitation programs.

2.**Nguyen PT et al., (2022)** Proprioceptive neuromuscular facilitation-based physical therapy on balance and gait in patients with chronic stroke, this study concluded that PNF-based therapy improves balance and gait in chronic stroke, enhances functional mobility, and is an effective rehabilitation approach.

3.**Yang YR et al., (2022)** Dual-task exercise improves walking ability in chronic stroke patients: a randomized controlled trial, this study concluded that dual-task training improves walking ability in stroke patients, enhances cognitive-motor coordination, and is useful for functional recovery.

4.**Plummer P et al., (2021)** Measuring treatment effects on dual-task performance in stroke rehabilitation, this study concluded that dual-task performance is important in stroke rehabilitation, reflects functional ability, and improves real-life task performance.

5.**Morton SM et al., (2021)** Postural control deficits in cerebellar damage, this study concluded that cerebellar damage leads to postural control deficits, affects balance and coordination, and rehabilitation is essential for recovery.

6.**Blum L et al., (2020)** Usefulness of the Berg Balance Scale in stroke rehabilitation, this study concluded that the Berg Balance Scale is reliable in stroke rehabilitation, effectively assesses balance, and is a useful clinical outcome measure.

7.**Skevington SM et al., (2020)** The World Health Organization's WHOQOL-BREF quality of life assessment: psychometric properties and results, this study concluded that WHOQOL-BREF is a valid tool for quality-of-life assessment, has good psychometric properties, and is widely applicable in clinical research.

8.**Winstein CJ et al., (2020)** Guidelines for adult stroke rehabilitation and recovery, this study concluded that comprehensive rehabilitation improves stroke recovery, multidisciplinary approaches are essential, and early intervention enhances outcomes.

METHODOLOGY:

- STUDY DESIGN : Comparative study design.
- STUDY SETTING : Ishari Velan mission hospital,Thazhambur.
- STUDY DURATION : 12 weeks
- STUDY METHOD : Convenient sampling
- SAMPLE SIZE : 30 subjects

INCLUSION CRITERIA:

- Individuals diagnosed with cerebellar stroke.
- Age group between 50 to 75 years.
- Both male and female participants.
- Individuals with impaired balance and gait disturbances.
- Ability to follow simple verbal command.
- Individuals with a history of at least one fall or risk of falls.
- Individuals able to stand with or without minimal assistance.

EXCLUSION CRITERIA:

- Stroke involving non-cerebellar regions.
- Severe cognitive impairment.
- Presence of other neurological disorders.
- Severe musculoskeletal conditions affecting mobility.
- Patients with severe visual or auditory impairments that interfere with training.
- Individuals with uncontrolled cardiovascular conditions (e.g., unstable angina, uncontrolled hypertension).
- Patients who are non-ambulatory or bedridden.

OUTCOME MEASURES:

- Berg Balance Scale (BBS)
- WHO-Quality of Life BREF Scale (WHO-QOL BREF)

PROCEDURE:

Total of 30 cerebellar stroke subjects who fulfilled the inclusion and exclusion criteria were selected for the study. Informed consent was obtained from the selected subjects and divided into 2 groups, GROUP A and GROUP B. Each group consists of 15 subjects. After completing the initial assessment, both the groups were assessed using Berg Balance Scale and WHO-Quality of Life BREF scale. These measurements were recorded as the pre-test values. Safety and security of the treatment was explained to all the subjects.

GROUP A - Received Proprioceptive Neuromuscular Facilitation:

PROGRESSION: For 4 times a week of 45 minutes per session for 12 weeks.

TECHNIQUE:

WARM UP EXERCISE (5 min):

- Deep Breathing
- Active Range of Motion

WEEK 1-2 (Early Stage – Facilitation & Control):

1. Pelvic Anterior Elevation (PNF) - 2 sets x 10 reps.

2. Trunk Rotation (Slow Reversal) - 2 sets x 10 reps each side.

3. Isometric Trunk Hold (Stabilizing Reversal) - Hold 5sec x 10 reps.

4. Lateral Weight Shifting - 2 sets x 10 reps.

WEEK 3-4 (Static → Dynamic Control):

5. Trunk Stability (Rhythmic Stabilization) - Hold 8 sec x 10 reps.

6. Pelvic PNF Patterns - 3 sets x 10 reps.

WEEK 5-6 (Functional Activation):

7. D1 Lower Limb Pattern - 3 sets x 10 reps each side.

8. Sit-to-Stand (Agonistic Reversal) - 3 sets x 10 reps.

WEEK 7-8 (Dynamic Balance Training):

9. PNF Gait Training - 10 to 15 minutes continuous walking.

10. Balance Perturbation Training - Hold 10 sec x 10 reps.

WEEK 9-10 (Advanced Balance & Fall Prevention):

11. Stepping Strategy Training - 3 sets x 10 reps.

12. Single Leg Stance - Hold 10 sec x 10 reps each side.

WEEK 11-12 (Dual Task & Functional Independence):

13. Dual Task Walking - 15 to 20 minutes.

14. Stair Climbing (PNF Facilitation) - 10 reps.

COOL DOWN EXERCISE (5 min):

- Deep Breathing
- Gentle Stretching

GROUP B - Received Dual Task Training:

PROGRESSION: For 4 times a week of 45 minutes per session for 12 weeks

TECHNIQUE:

WARM UP EXERCISE (5 min):

- Deep Breathing
- Trunk Rotation + Talking

WEEK 1-2 (Initial phase - Basic Dual Task Training):

1.Sitting Balance + Counting - 2 sets x 2 minutes.
2.Arm Movement + Counting – 2 sets x 10 reps.
3.Ball Holding + Naming - 2 sets x 2 minutes.

WEEK 3-4 (Progression Phase I - Transitional dual task training):

1.Trunk Rotation + Talking - 2 sets x 10 reps.
2.Sit-to-Stand + Counting - 3 sets x 10 reps.

WEEK 5-6: (Progression Phase II – Static balance dual task training):

6. Standing + Naming Objects - 2 sets x 2 minutes.

7. Weight Shifting + Counting - 2 sets x 10 reps.

8. Ball Toss + Words - 2 sets x 10 reps.

WEEK 7-8 (Advanced Phase I - Dynamic balance dual task training):

9. Standing Balance + Counting Backwards - 2 sets x 2 minutes.

10. Marching + Naming - 3 sets x 1 minute.

WEEK 9-10 (Advanced Phase II - Ambulation with dual task):

11. Obstacle walking + Counting - 10 minutes.

12. Side Stepping + Counting - 3 sets x 10 steps each side.

WEEK 11-12 (Functional Phase - Functional dual task training):

13. Walking + Carry Object - 10 to 15 minutes.

14. Stair Climbing + Counting - 10 reps.

COOL DOWN EXERCISE (5 min):

- Deep Breathing
- Gentle Stretching

DATA ANALYSIS:

The collected data were tabulated and analysed using both descriptive and inferential statistics. All the parameters were assessed using statistical package for social science (SPSS) version 28.0. Paired t-test was adopted to find the statistical difference within the groups & Independent t-test was adopted to find the statistical difference.

TABLE -1

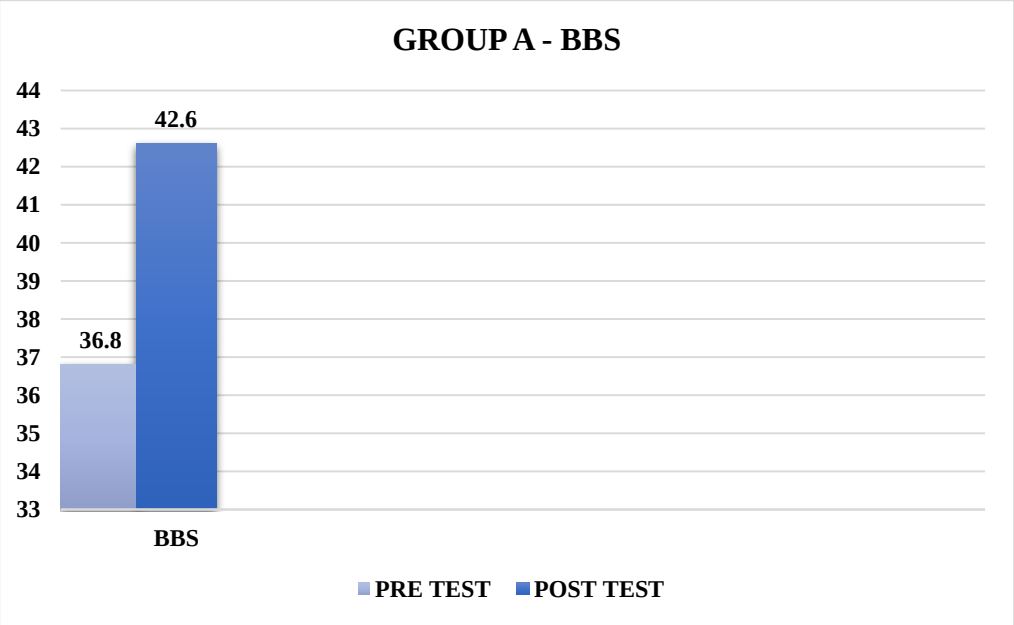
COMPARISON OF PRE AND POST-TEST VALUES OF BBS IN GROUP A
DESCRIPTIVE STATISTICS:

VARIABLE	MEAN	STD.DEV	STD.ERR
PRE TEST	36.80	1.50	0.33
POST TEST	42.60	1.90	0.49

PAIRED t- TEST:

H_0.Diff	MEAN DIFF	SE.DIFF	t VALUE	DF	p VALUE
0.000	5.80	0.32	18.12	14	$p < 0.001$

INTERPRETATION: The above table shows the comparison between Pre and Post-test values of Berg Balance Scale in GROUP A.



GRAPH 1: Represents the GROUP A Pre and Post-test values of BBS.

TABLE- 2

COMPARISON OF PRE AND POST-TEST VALUES OF BBS IN GROUP B

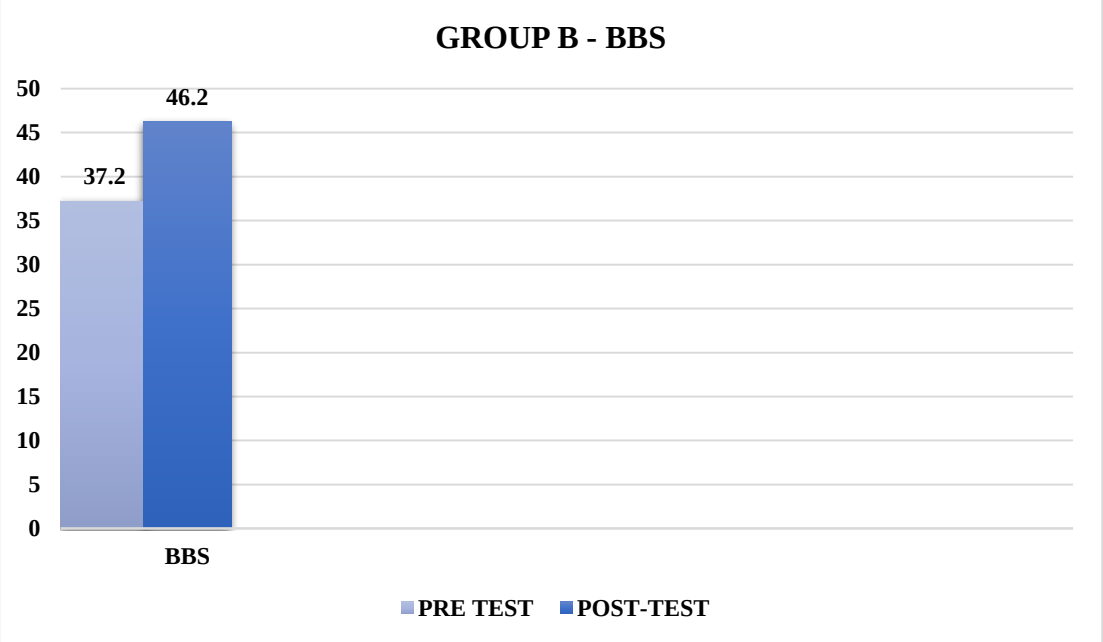
DESCRIPTIVE STATISTICS:

VARIABLE	MEAN	STD.DEV	STD.ERR
PRE TEST	37.20	1.40	0.36
POST TEST	46.20	1.30	0.33

PAIRED t- TEST:

H_0.Diff	MEAN DIFF	SE.DIFF	t VALUE	DF	p VALUE
0.000	9.00	0.28	32.14	14	$p < 0.001$

INTERPRETATION: The above table shows the comparison between Pre and Post-test values of Berg Balance Scale in GROUP B



GRAPH 2: Represents the GROUP B Pre and Post-test values of BBS

TABLE -3

COMPARISON OF BBS BETWEEN GROUP A AND GROUP B

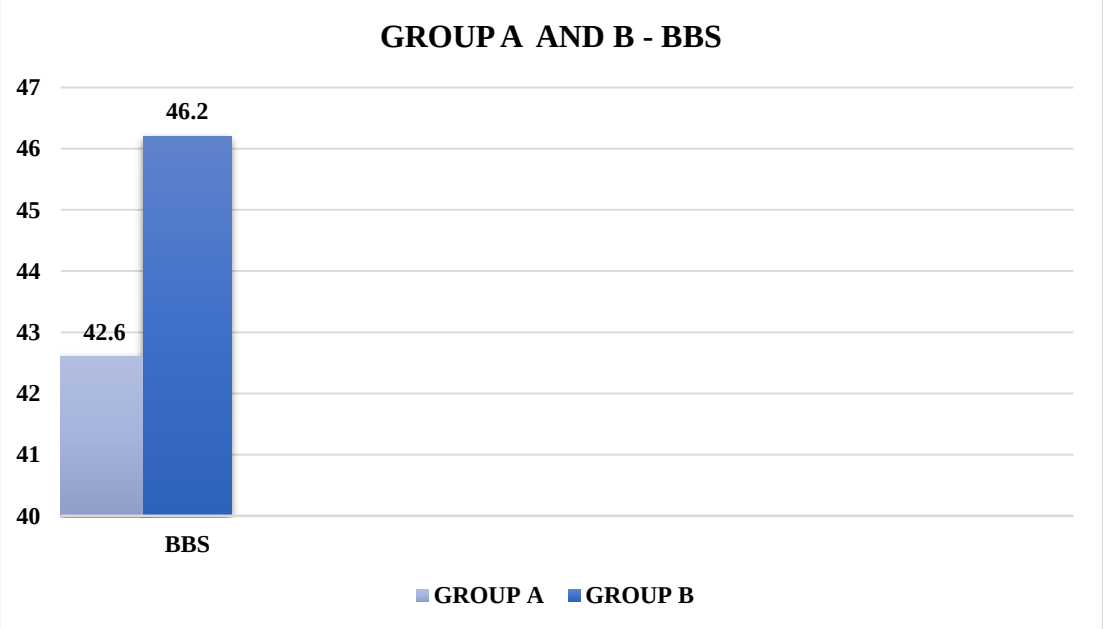
DESCRIPTIVE STATISTICS:

VARIABLE	MEAN	STD.DEV	STD.ERR
POST TEST GROUPA	42.60	1.90	0.49
POST TEST GROUP B	46.20	1.30	0.33

BETWEEN GROUP COMPARISON (INDEPENDENT t-Test):

H_0.Diff	MEAN DIFF	SE.DIFF	t VALUE	DF	p VALUE
0.000	3.60	0.55	6.54	28	$p < 0.001$

INTERPRETATION: The above table shows the comparison of Berg Balance Scale values in GROUP A and GROUP B



GRAPH 3: Represents BBS % increase between Group A and B.

TABLE -4

COMPARISON OF PRE AND POST-TEST VALUES OF WHO-QOL BREF SCALE IN GROUP A

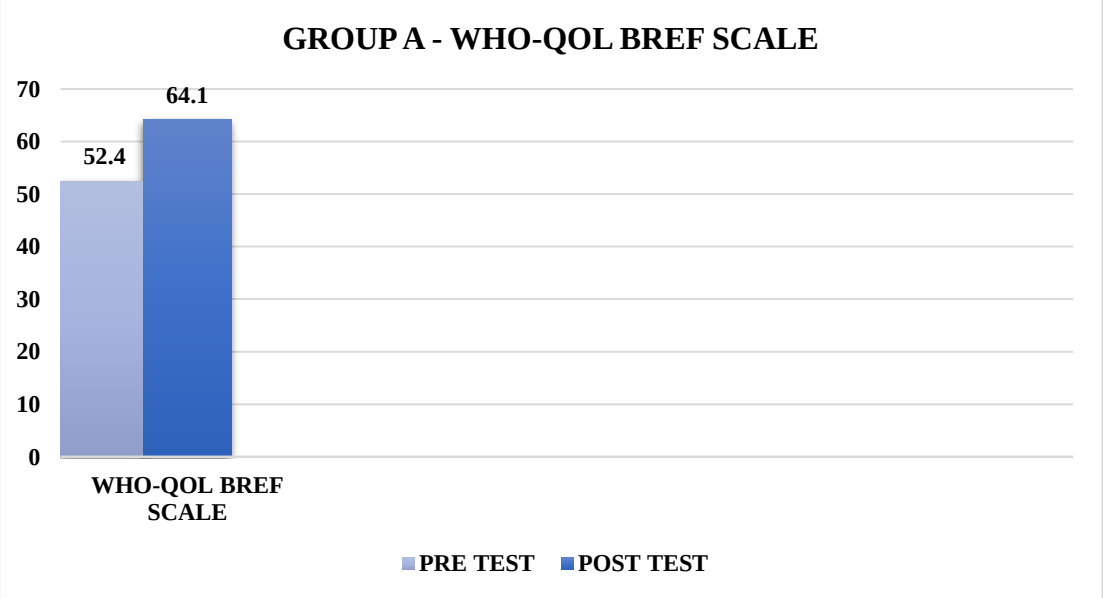
DESCRIPTIVE STATISTICS:

VARIABLE	MEAN	STD.DEV	STD.ERR
PRE TEST	52.40	3.20	0.83
POST TEST	64.10	3.50	0.90

PAIRED t- TEST:

H_0.Diff	MEAN DIFF	SE.DIFF	t VALUE	DF	p VALUE
0.000	11.70	0.75	15.60	14	$p < 0.001$

INTERPRETATION: The above table shows the comparison between Pre and Post-test values of WHO-QOL BREF Scale in GROUP A.



GRAPH 4: Represents the GROUP A Pre and Post-test values of WHO-QOL BREF Scale.

TABLE- 5

COMPARISON OF PRE AND POST TEST VALUES OF WHO-QOL BREF SCALE IN GROUP B

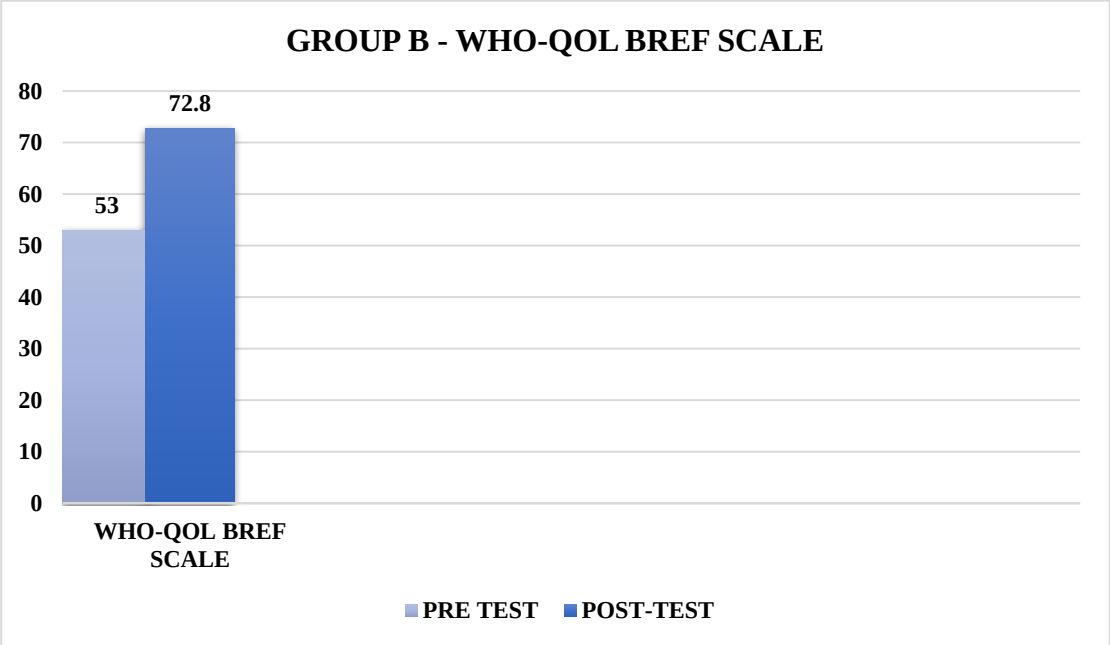
DESCRIPTIVE STATISTICS:

VARIABLE	MEAN	STD.DEV	STD.ERR
PRE TEST	53.00	3.00	0.77
POST TEST	72.80	3.10	0.80

PAIRED t- TEST:

H_0.Diff	MEAN DIFF	SE.DIFF	t VALUE	DF	p VALUE
0.000	19.80	0.68	29.11	14	$p < 0.001$

INTERPRETATION: The above table shows the comparison between Pre and Post-test values of WHO-QOL BREF Scale in GROUP B



GRAPH 5: Represents the GROUP B Pre and Post-test values of WHO-QOL BREF Scale.

TABLE -6

COMPARISON OF WHO-QOL BREF SCALE BETWEEN GROUP A AND GROUP B

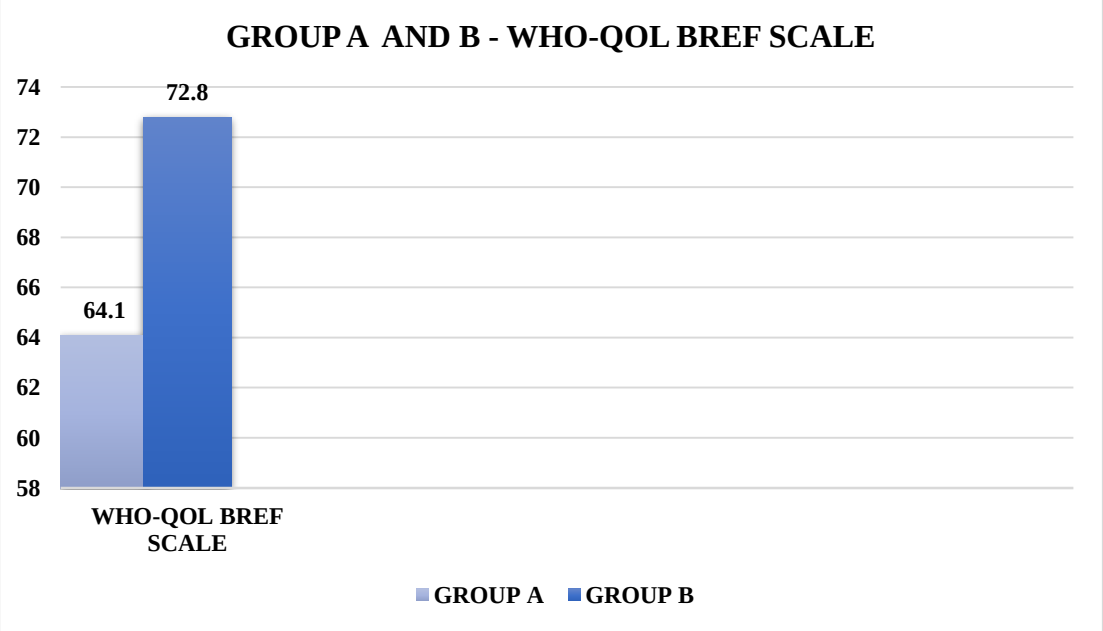
DESCRIPTIVE STATISTICS:

VARIABLE	MEAN	STD.DEV	STD.ERR
POST TEST GROUP A	64.10	3.50	0.90
POST TEST GROUP B	72.80	3.10	0.80

BETWEEN GROUP COMPARISON (INDEPENDENT t-test):

H_0.Diff	MEAN DIFF	SE.DIFF	t VALUE	DF	p VALUE
0.000	8.70	1.18	7.37	28	$p < 0.001$

INTERPRETATION: The above table shows the comparison of WHO-QOL BREF Scale values in GROUP A and GROUP B.



GRAPH 6: Represents WHO-QOL BREF Scale % increase between Group A and B.

RESULT:

1.BBS (Berg Balance Scale): In Group A, the mean pre-test BBS score was 36.80 ± 1.50, which increased to 42.60 ± 1.90 in the post-test. The calculated t-value was 18.12 with a p-value of $p < 0.0001$, indicating a highly statistically significant improvement in balance following the intervention. In Group B, the mean pre-test BBS score was 37.20 ± 1.40, which increased to 46.20 ± 1.30 in the post-test. The calculated t-value was 32.14 with a p-value of $p < 0.0001$, showing a highly statistically significant improvement in balance following the intervention.

2.WHO-QOL BREF (World Health Organization Quality of Life-BREF Scale): In Group A, the mean pre-test WHO-QOL BREF score was 52.40 ± 3.20, which increased to 64.10 ± 3.50 in the post-test. The calculated t-value was 15.60 with a p-value of $p < 0.0001$, indicating a highly statistically significant improvement in quality of life following the intervention. In Group B, the mean pre-test WHO-QOL BREF score was 53.0 ± 3.0, which increased to 72.80 ± 3.10 in the post-test. The calculated t-value was 29.11 with a p-value of $p < 0.0001$, showing a highly statistically significant improvement in quality of life following the intervention.

DISCUSSION:

The present study aimed to compare the effectiveness of Proprioceptive Neuromuscular Facilitation and Dual Task Training in preventing falls and improving quality of life among cerebellar stroke individuals. The findings of this study indicated that both interventions were effective in improving balance and quality of life; however, Dual Task Training showed greater improvement compared to Proprioceptive Neuromuscular Facilitation. The improvements observed can be attributed to enhanced neuroplasticity, sensory-motor integration, and postural control mechanisms. Proprioceptive Neuromuscular Facilitation utilizes diagonal and spiral movement patterns with proprioceptive stimulation to improve neuromuscular coordination, muscle activation, and balance control. This promotes reorganization of neural pathways involved in motor control and postural stability. Previous studies have shown that PNF effectively improves gait, balance, and functional mobility in stroke rehabilitation. Dual Task Training, which combines simultaneous motor and cognitive activities, enhances attention, executive function, and automaticity of movement. This approach improves the ability to maintain balance while performing functional activities under real-life conditions. By stimulating multiple brain regions including the cerebellum and prefrontal cortex, dual task training promotes better cognitive-motor integration, gait stability, and adaptive postural responses. Previous research has demonstrated significant improvements in balance, walking performance, and activities of daily living following dual task interventions in stroke patients. These mechanisms likely contributed to the superior improvements observed in the present study.

CONCLUSION:

The present study concludes that both Proprioceptive Neuromuscular Facilitation (PNF) and Dual Task Training are effective in preventing falls and improving quality of life among cerebellar stroke individuals, as evidenced by significant improvements in the Berg Balance Scale (BBS) and WHO-Quality of Life BREF Scale. However, Dual Task Training demonstrated greater effectiveness compared to PNF, possibly due to its ability to simultaneously enhance cognitive and motor functions, thereby improving functional balance and performance during daily activities. Although PNF was effective in improving balance and quality of life, it showed relatively lesser improvement in functional mobility when compared to Dual Task Training. Therefore, Dual Task Training can be considered a more effective intervention for fall prevention and improvement of quality of life among cerebellar stroke individuals.

LIMITATIONS OF THE STUDY:

- The study included limited sample size.
- The intervention period was short.
- Participants were recruited from one centre**,** which may limit how widely the results can be applied.
- Only two outcome measures were used.
- Lack of long term follow up.

RECOMMENDATIONS OF THE STUDY:

- Studies with larger sample sizes.
- The duration of the study can be increased.
- Long-term follow-up to assess retention of improvements.
- Use additional outcome measures - gait analysis, fall records, and cognitive tests.
- Include more participants and conduct studies in multiple centres.

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