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Effect Of Task-Oriented Strength Training On Upperlimb Spasticity, Grip Strength And Activities Of Daily Living Among Subjects With Sub Acute Stroke

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ABSTRACT

INTRODUCTION:

Stroke is a clinically defined syndrome of acute, focal neurological deficit attributed to vascular injury (infarction, hemorrhage) of the central nervous system (1). Stroke is one of the leading causes of physical disability in adult population. About 85% patients has motor impairments in affected upper limb with first episode of stroke and this upper extremity motor deficit remain in 55 to75% patients even after six months of stroke. Spastic paralysis is common sequel of stroke, and approximately 17% to 40% of patients experienced post stroke upper limb spasticity (3). Hand Grip Strength is important because, 45% of all activities of daily living (ADLs) are performed by this strength. Activities of daily living like eating, bathing, brushing, combing hair, ironing clothes, require minimum holding capacity of the hand. Without enough grip force, person will not be able to perform his daily living tasks (2).

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PURPOSE:

The study aims at evaluating the effect of Task-Oriented Strength Training (TOST) on Spasticity, grip strength and activities of daily living among the subjects with sub-acute stroke.

METHOD:

The data of 30 subjects with sub-acute stroke with a mean age 45 to 65 years were included in the study based on the inclusion criteria. The subjects were divided into experimental and control groups. The experimental group received Task oriented strength training and conventional therapy. In contrast, the control group received Home exercises and conventional therapy.

STATISTICAL ANALYSIS:

Pre and post-values were measured by using a Wilcoxon signed rank test within the group and the Mann-Whitney U tests to measure the data between the groups.

RESULTS:

The mean age of participants in the Experimental group was 48.33 ± 6.47 years, while the Control group had a mean age of 54.20 ± 6.12 years. Pre-treatment values for the Experimental group were: MAS – 1.80 ± 0.41, MST (Affected) – 105.33 ± 14.94, MST (Unaffected) – 177.33 ± 38.26, and BI – 75.00 ± 3.78. In the Control group, pre-treatment values were: MAS: 1.47 ± 0.52, MST (Affected): 111.33 ± 24.01, MST (Unaffected)–154.67 ± 40.86, and BI: 74.00 ± 4.31.

Post-treatment results showed substantial improvements in the Experimental group: MAS reduced to 0.07 ± 0.26, MST (Affected) increased to 172.00 ± 14.24, MST (Unaffected) to 212.67 ± 35.55, and BI to 89.33 ± 3.72. In comparison, the Control group showed more modest gains: MAS – 0.53 ± 0.52, MST (Affected) – 142.67 ± 26.58, MST (Unaffected) – 178.00 ± 40.92, and BI – 80.00 ± 5.35. Statistical analysis revealed a significant improvement in the Experimental group compared to the Control group ($p = 0.001$), confirming the effectiveness of the intervention.

CONCLUSION:

The study shows that combined task-oriented strength training and conventional treatment was found to be effective in improving the upper limb spasticity, grip strength, and activities of daily living in subjects with sub-acute stroke

Introduction:

- Stroke is a clinically defined syndrome of acute, focal neurological deficit attributed to vascular injury (infarction, hemorrhage) of the central nervous system.
- According to the World Health Organization, stroke is the second most common cause of mortality and disability worldwide (1).
- The cumulative incidence of stroke in India ranged from 105 to 152/100,000 persons per year during the past two decades in different parts of the country.
- Stroke prevalence in different parts of India ranged from 44.29 to 559/100,000 persons during the past two decades (2).
- Hand Grip Strength is important because, 45% of hand functions require adequate strength to perform ADL's. Without enough grip force, person will not be able to perform his daily living tasks (3).
- Spastic paralysis is common sequelae of stroke, and approximately 17% to 40% of patients experienced post stroke upper limb spasticity (4).
- A variety of interventions can be used to enhance upper limb function following a stroke. These interventions may target specific impairments, such as muscle weakness, or focus on improving functional movements like grasping and releasing.
- Traditional rehabilitation therapies include bilateral arm training, biofeedback, the Bobath approach, electrical stimulation, the Motor Relearning Program (MRP), hands-on therapy (manual techniques), mirror therapy, music therapy, repetitive task training, sensory interventions (to improve sensory function), task-specific training, reach-to-grasp exercises, strength training, stretching and positioning, Constraint-Induced Movement Therapy (CIMT), and modified CIMT (m-CIMT).

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- Recent advances include transcranial Direct Current Stimulation (tDCS), Transcranial Magnetic Stimulation (TMS), Mental Practice, Robotics, and Virtual Reality Therapy (VRT) (13).
- Task-oriented training is an activity-centered approach in which a task is repeatedly trained with an emphasis on functional performance in order to effectively complete the task. Task oriented strength training provides an appropriate stimulus to improve hand grip strength (6).
- Besides these therapeutic approaches, varieties of physical therapy modalities are used for the rehabilitation of stroke patient. Electrical stimulation is one of the most commonly used electrotherapeutic modality which is used to stimulate the paretic limb (7).

AIM OF THE STUDY:

To determine the effect of Task-Oriented Strength Training on upper limb Spasticity, grip strength and activities of daily living among the subjects with sub-acute stroke

OBJECTIVES OF THE STUDY:

i. To evaluate the effectiveness of Task Oriented Strength Training

a) On upper limb spasticity, by using Modified Ashworth Scale (MAS),

b) On grip strength, by using Modified Sphygmomanometer Test (MST) and

c) On activities of daily living by using Barthel Index (BI) among subjects with sub-acute stroke.

ii. To evaluate the effectiveness of Conventional therapy

a) On upper limb spasticity, by using Modified Ashworth Scale,

b) On grip strength, by using Modified Sphygmomanometer Test and

c) On activities of daily living by using Barthel Index among subjects with sub-acute stroke.

Methodology:-

Materials :- Modified sphygmomanometer, Chair, Therapeutic Electrical stimulator, Table, A4 paper, Plastic water bottle, Sand bag, Cloth, Clay, Cup, Wooden blocks

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Methods:-

Inclusion criteria:

- Subjects of age group 40-65 years
- Both males and females
- Ischemic stroke
- Strokes on both the right and left sides
- 1 month to 6 months after stroke onset.
- Subject with MMSE (Mini Mental Status Examination) Score >_23
- Subjects with Voluntary Control Grading 4 (Gross grasp present; lateral prehension developing; small amount of finger extension and some thumb movement possible)
- Spasticity with Modified Ashworth scale (MAS) Grade 2(More marked increase in muscle tone through most of ROM, but affected parts easily moved)

Exclusion criteria:

- Recurrent stroke
- Subjects with cognitive deficits
- Un co-operative subjects
- Any sensory impairment
- Subjects with perceptual problems
- Subjects implanted with cardiac pacemaker
- Subjects with musculoskeletal dysfunction in upper limb
- Who are unable to be under regular follow up

Study Design: Randomized Control trail

Sampling technique: Purposive sampling method.

Randomization method: Simple randomization by lottery method.

Sample Size (N): 30 stroke subjects (Group-A (n) =15 subjects, Group-B (n) =15 subjects)

Treatment duration: 6 weeks

Table.1: Treatment Protocol

Experimental group (Group - A)	**Control group (Group - B)**
A) Task oriented strength training exercises to affected limb: 1. Carrying and transferring a plastic bottle of water from the unaffected hand to the affected hand. 2. Transferring a sandbag from the unaffected hand to the affected hand 3. Crumpling a sheet of paper into a ball and attempting to spread it back into a flat piece 4. Molding with clay 5. Wringing out the wet cloth 6. Holding a drinking cup 7. Carrying and dragging wooden blocks • **Treatment Duration**: Perform each task for a total of ten repetitions, 30 minutes/ day for 5 days a week for a total duration of 6 weeks. **B) Conventional therapy**	**A) Home exercises:** Includes hand and finger exercises: 1. Fist clenching 2. Finger stretch 3. Finger spreading` 4. Ball squeezing 5. Finger extension 6. Thumb extension 7. Thumb flexion and 8. Thumb stretches • **Treatment duration:** Perform each exercise for a total of ten repetitions, 30 minutes/day for 5 days a week for a total duration of 6 weeks. **B) Conventional therapy**

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i) Electrical Stimulations for extensors of wrist and fingers: Motor points for individual muscles a) Extensor Indicis, b) Extensor pollicis brevis, c) Extensor Digitorum, d) Extensor pollicis longus, e) Adductor pollicis, f) Extensor carpi radialis longus & brevis, g) Extensor digiti minimi and h) Abductor pollicis longus. • **Treatment Duration:**15 minutes /day for 5 days a week for a total duration of 6 weeks **ii) Stretchings and ROM exercises** 1. Stretchings to flexors of forearm and hand 2. Shoulder ROM exercises, 3. Elbow ROM exercises, and 4. Wrist ROM exercises • **Treatment duration:** Perform each exercise for a total of ten repetitions, 15minutes/day for 5 days a week for a total duration of 6 weeks.	**i) Electrical Stimulations for extensors of wrist and fingers**: Motor points for individual muscles a) Extensor Indicis, b) Extensor pollicis brevis, c) Extensor Digitorum, d) Extensor pollicis longus, e) Adductor pollicis, f) Extensor carpi radialis longus & brevis, g) Extensor digiti minimi and h) Abductor pollicis longus. • **Treatment Duration:**15 minutes /day for 5 days a week for a total duration of 6 weeks **ii) Stretchings and ROM exercises** 1. Stretchings to flexors of forearm and hand 2. Shoulder ROM exercises, 3. Elbow ROM exercises, and 4. Wrist ROM exercises • **Treatment duration:** Perform each exercise for a total of ten repetitions, 15minutes/day for 5 days a week for a total duration of 6 weeks.

STATISTICAL ANALYSIS:

Statistical analysis was conducted using International Business Machines Statistical Package for the Social Sciences (IBM SPSS) software (version 27). Data were initially entered and tabulated in Microsoft Excel before analysis. All 30 participants completed the study protocol

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within six weeks of treatment. Demographic data were analysed, and the Shapiro-Wilk test was used to assess the normality of outcome variables in both the experimental and control groups. Results indicated that most outcome variables, particularly in the experimental group, did not follow a normal distribution. Therefore, non-parametric tests were used: the Wilcoxon Signed-Rank Test for within-group comparisons and the Mann–Whitney U Test for between-group comparisons. This method offered more accurate and trustworthy statistical conclusions based on the distribution of the data.

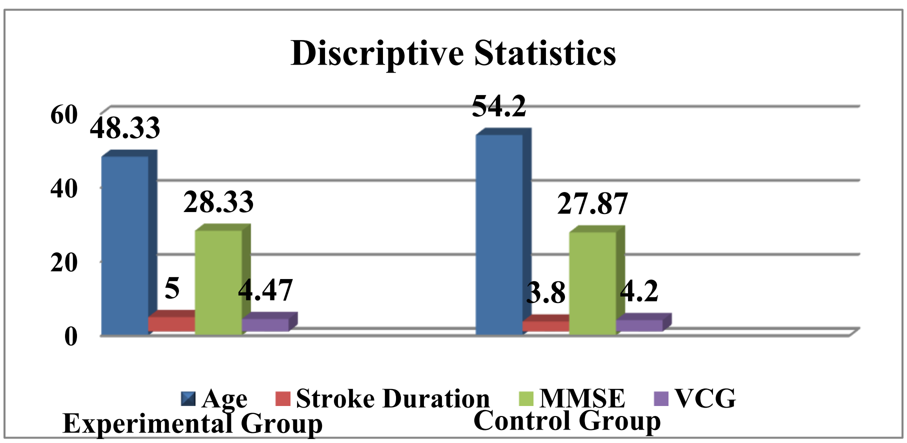
Results:

A) Descriptive statistics:

Table - 2 Comparison of Demographic Variables between Experimental and Control groups

Variable	Experimental Group		control group	
	Mean	SD	Mean	SD
Age	48.33	6.47	54.20	6.12
Stroke Duration	5.00	1.00	3.80	1.15
MMSE	28.33	1.18	27.87	1.77
VCG	4.47	0.52	4.20	0.41

Graph- 1: Graphical representation of Comparison of Demographic Variables between Experimental and Control groups



Interpretation: **Age**: Experimental group (48.33 ± 6.47) was younger than the control group (54.20 ± 6.12). **Stroke Duration**: Experimental group had longer post-stroke duration (5.00 ± 1.00 years) vs. control (3.80 ± 1.15 years). **MMSE**: Cognitive scores were preserved in both groups (Experimental: 28.33 ± 1.18; Control: 27.87 ± 1.77). **VCG**: Slightly higher in experimental group (4.47 ± 0.52) vs. control (4.20 ± 0.41), indicating better motor control.

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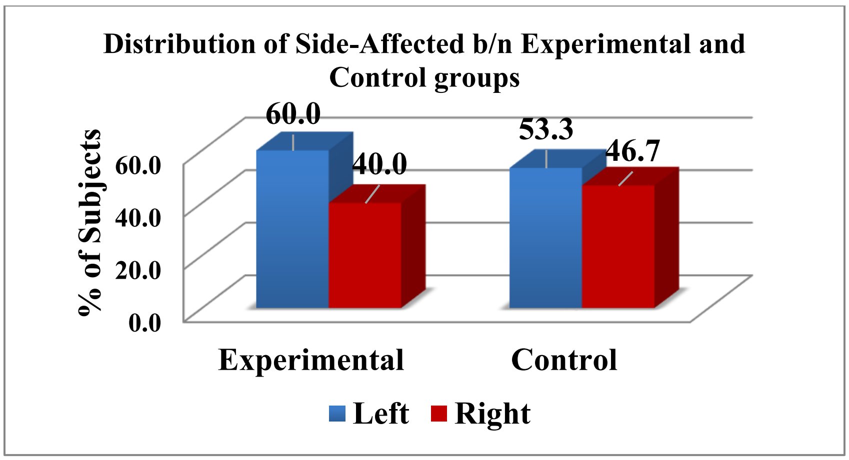
Table - 3 Comparison of side affected between Experimental and Control groups.

Side Affected	Experimental	Control
Left	9 (60%)	8 (53%)
Right	6 (40%)	7 (47%)
Total	15 (100%)	15 (100%)

Graph- 2: Graphical representation of Distribution of Side-Affectedin experimental and control groups



Interpretation: Both groups had a similar distribution of stroke side: Experimental (60% left, 40% right), Control (53% left, 47% right), ensuring balance in limb involvement.

Table - 4 Comparison of Gender Distribution between Experimental and Control groups

Gender	Experimental	Control
Female	2 (13%)	5 (33%)
Male	13 (87%)	10 (67%)
Total	15 (100%)	15 (100%)

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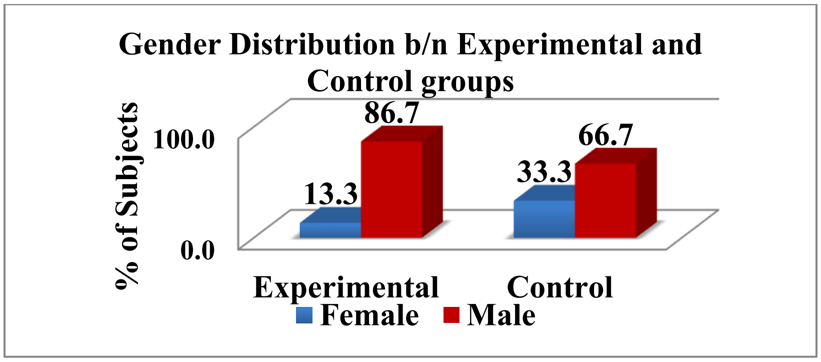
Graph- 3: Graphical representation of Gender Distribution in experimental and control groups



Interpretation: Male participants dominated both groups: Experimental (87%), Control (67%). Control group had more females (33%).

B) Inferential statistics:

Table - 5: Showing Tests of Normality – by Shapiro-Wilk Test

Tests of Normality - Shapiro-Wilk Test			
	Group	**Statistic**	**P-value**
MAS-Pre	Experimental	0.50	0.000
	Control	0.64	0.000
MAS-Post	Experimental	0.28	0.000
	Control	0.64	0.000
MST Affected –Pre	Experimental	0.69	0.000
	Control	0.90	0.095
MST Affected-Post	Experimental	0.79	0.003
	Control	0.92	0.229
MST-Unaffected-Pre	Experimental	0.87	0.038
	Control	0.86	0.025
MST-Unaffected-Post	Experimental	0.90	0.103
	Control	0.87	0.034
BI-Pre	Experimental	0.82	0.007
	Control	0.77	0.002
BI-Post	Experimental	0.82	0.006
	Control	0.83	0.008

Interpretation: Most variables (especially MAS and BI) violated normality assumptions, justifying the use of **non-parametric tests**:

- **Wilcoxon Signed-Rank Test** for within-group comparisons
- **Mann–Whitney U Test** for between-group comparisons

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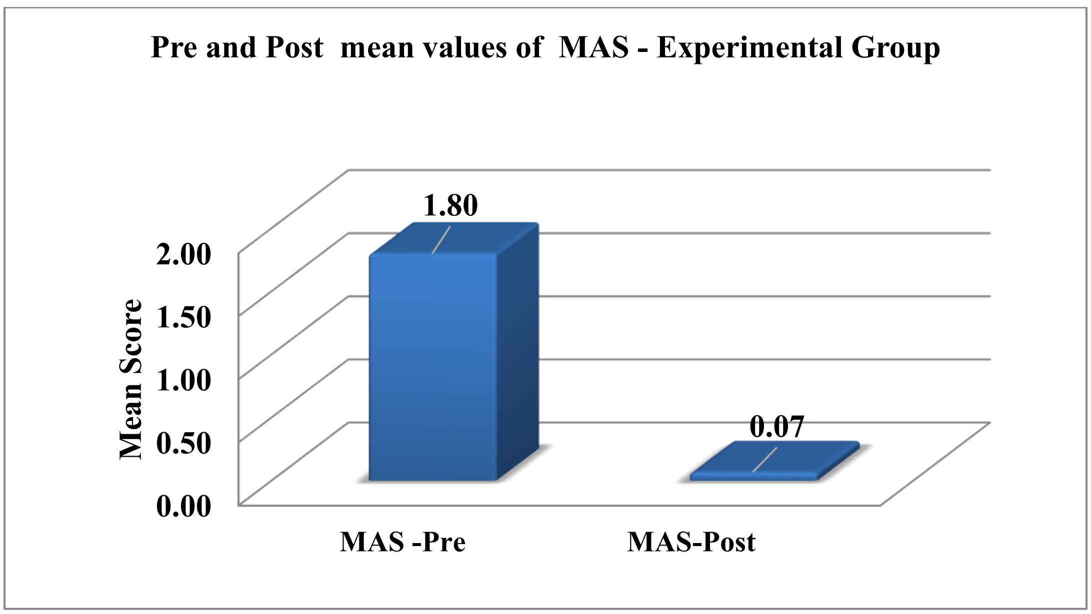
Table-6 Within-Group analysis of Pre- and Post-Intervention mean values of MAS, MST (Affected and Unaffected hand), and BI of experimental group- by Wilcoxon Signed-Rank Test

Experimental Group								
	MAS		**MST Affected**		**MST Unaffected**		**BI**	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	1.80	0.07	105.33	172.00	177.33	212.67	75.00	89.33
SD	0.41	0.26	14.94	14.24	38.26	35.55	3.78	3.72
Mean difference	-1.73		66.67		35.34		14.33	
Z (post-pre)	–3.58		–3.46		–3.43		–3.50	
P-value	**0.000**		**0.001**		**0.001**		**0.000**	

Graph- 4: Graphical representation of pre- and post-values of MAS in the Experimental group.



- **Interpretation:** Spasticity, measured by the Modified Ashworth Scale (MAS), decreased from a mean of 1.80 (pre) to 0.07 (post). The Wilcoxon test yielded a Z-value of –3.58 and a p-value of 0.000, indicating a highly significant reduction in muscle tone and improved spasticity in experimental group.

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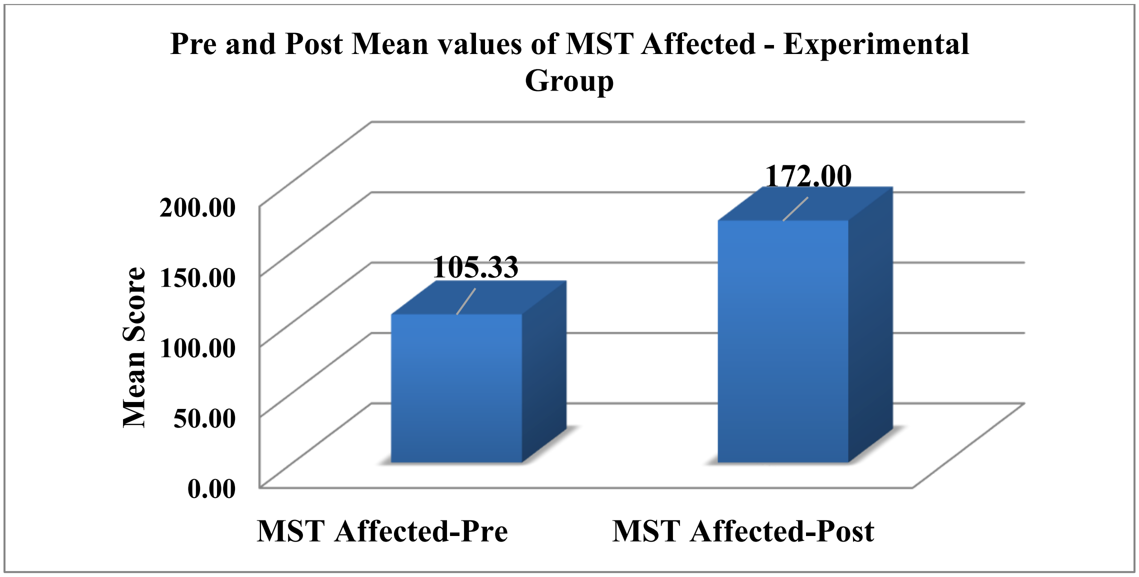
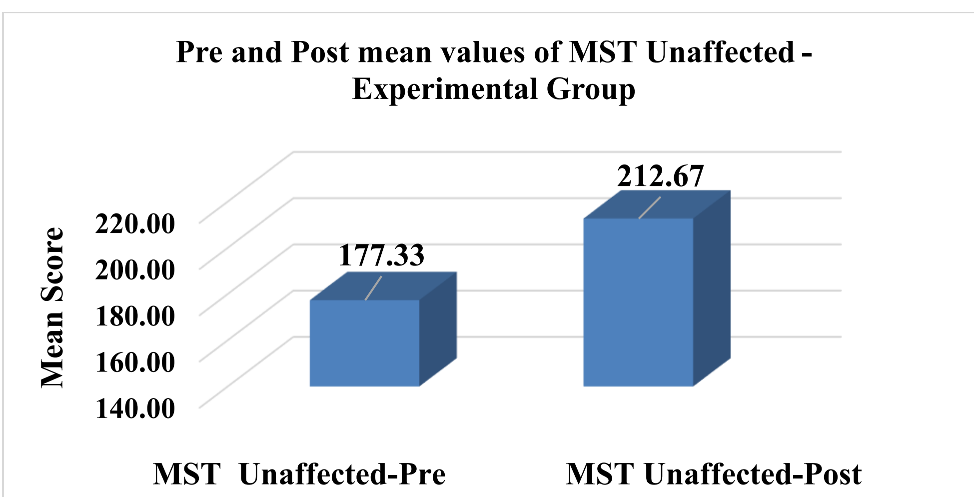
Graph-5: Graphical representation of pre- and post-values of MST of affected hand in the Experimental group.



- **Interpretation:** Grip strength of the affected limb, measured by the Modified Sphygmomanometer Test (MST), increased from a mean of 105.33 (pre) to 172.00 (post). The Wilcoxon test showed a Z-value of –3.46 and a p-value of 0.001, indicating a statistically significant improvement in experimental group.

Graph- 6: Graphical representation of pre- and post-values of MST of Unaffected hand in the Experimental group.



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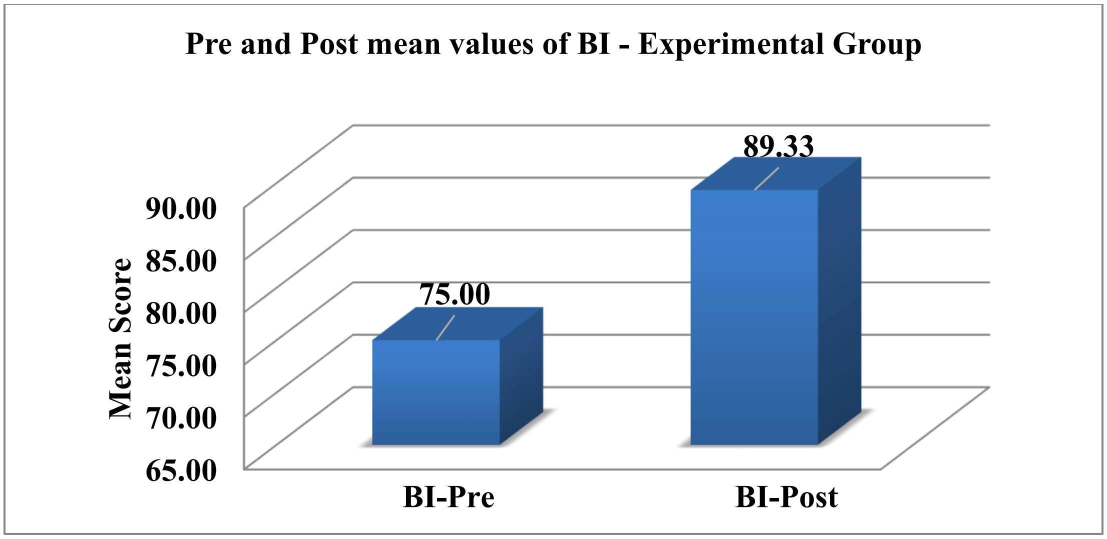
- **Interpretation:** For the unaffected limb, a significant improvement in grip strength was observed, with the mean score increasing from 177.33 to 212.67 following the intervention. This change was statistically supported by a Wilcoxon signed-rank test, yielding a Z-value of –3.43 and a p-value of 0.001in experimental group.

Graph-7: Graphical representation of pre- and post-values of BI in the Experimental group



- **Interpretation:** For activities of daily living, as assessed by the Barthel Index (BI), a notable improvement in functional independence was observed. The mean BI score increased from 75.00 before the intervention to 89.33 after the intervention period. The statistical analysis using the Wilcoxon signed-rank test yielded a Z-value of –3.50 with a p-value of 0.000, indicating that the improvement was highly significant. This result demonstrated that participants showed enhanced ability to perform essential daily activities following the intervention in experimental group.

Table-7 Within-Group analysis of Pre- and Post-Intervention mean values of MAS, MST (Affected and Unaffected hand), and BI of control group- by Wilcoxon Signed-Rank Test

Control Group								
	MAS		MST Affected		MST Unaffected		BI	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	1.47	0.53	111.33	142.67	154.67	178.00	74.00	80.00
SD	0.52	0.52	24.01	26.58	40.86	40.92	4.31	5.35
Mean difference	-0.94		31.34		23.33		6.00	
Z	–3.50		–3.45		–3.54		–3.63	
P-value	**0.000**		**0.001**		**0.000**		**0.000**	

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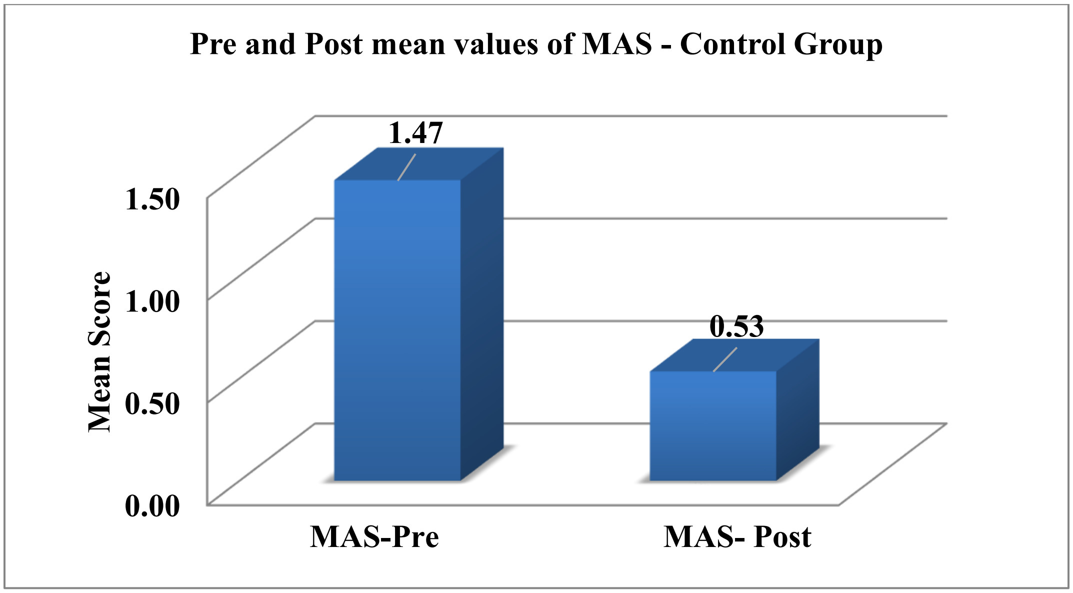
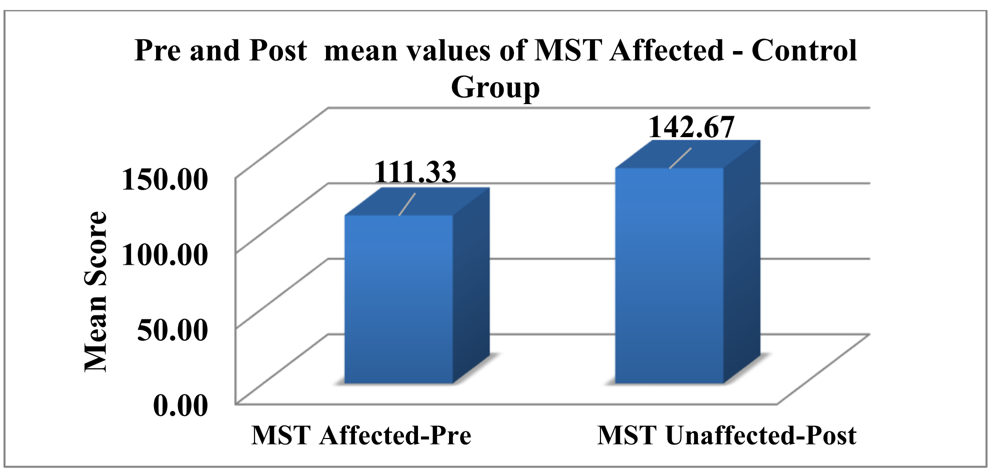
Graph-8: Graphical representation of pre- and post-values of MAS in the Control group.



- **Interpretation:** Spasticity, assessed using the Modified Ashworth Scale (MAS), showed a decrease in mean scores from 1.47 (pre-intervention) to 0.53 (post-intervention). The Wilcoxon Signed-Ranks Test yielded a Z-value of –3.50 with a p-value of 0.000, indicating a statistically significant reduction in muscle tone in control group.

Graph- 9: Graphical representation of pre- and post-values of MST of affected hand in the Control group



- **Interpretation:** Grip strength in the affected limb, measured by MST, increased from a mean of 111.33 pre-intervention to 142.67 post-intervention. The Wilcoxon Signed-Ranks Test produced

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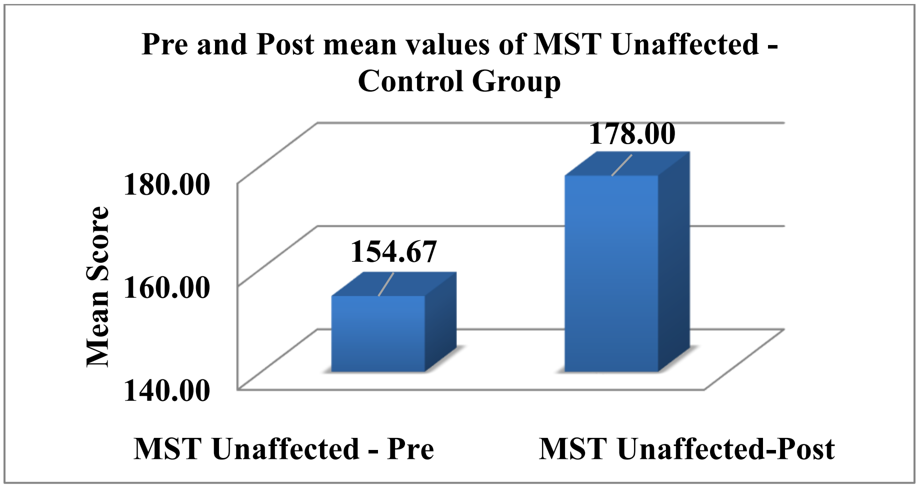
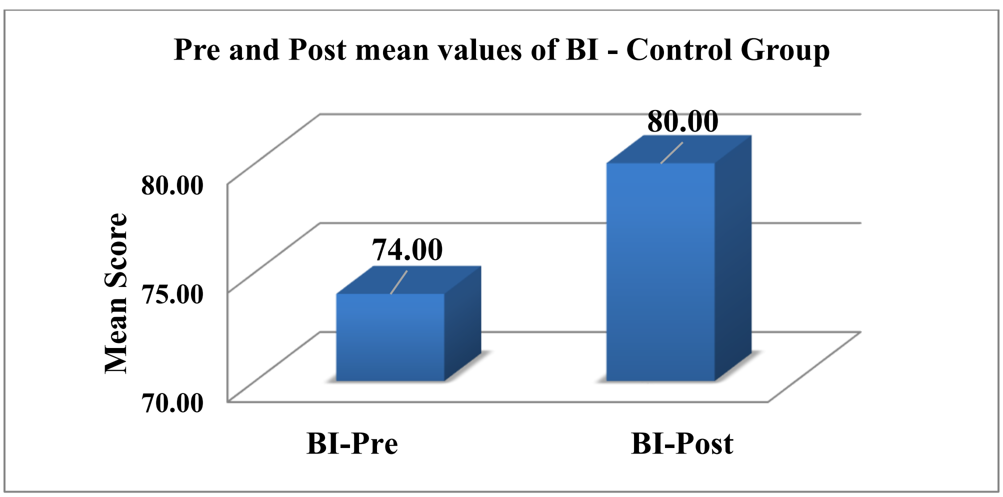
a Z-value of –3.45 with a p-value of 0.001, indicating a statistically significant improvement in muscle strength in control group.

Graph-10: Graphical representation of pre- and post-values of MST of Unaffected hand in the Control group.



- **Interpretation:** For the unaffected limb, the mean grip strength increased from 154.67 before the intervention to 178.00 after the intervention. The Wilcoxon Signed-Ranks Test produced a Z-value of –3.54 and a p-value of 0.000, which indicated a statistically significant improvement in grip strength. These results demonstrated a notable enhancement in the functional capacity of the unaffected hand following the intervention period in control group.

Graph-11: Graphical representation of pre- and post-values of BI in the Control group.



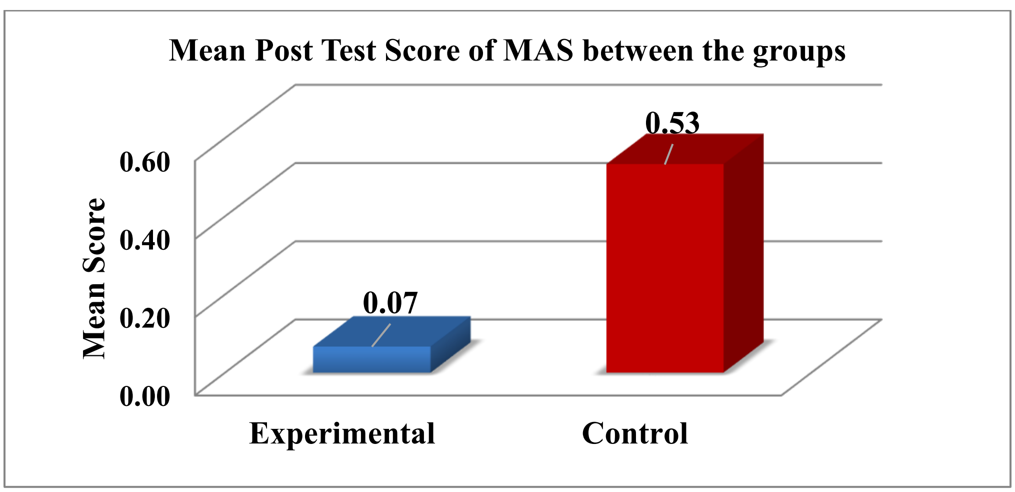
- **Interpretation:** Functional independence, assessed using the Barthel Index (BI), increased from a mean score of 74.00 before the intervention to 80.00 after the intervention. The Wilcoxon Signed-

Ranks Test yielded a Z-value of –3.63 with a p-value of 0.000, indicating a statistically significant improvement in the ability to perform daily living activities. These findings reflect a meaningful enhancement in functional independence following the intervention period.

Table-08: Between-group analysis of MAS, MST (affected and unaffected hand), and BI scores using the Mann-Whitney U test.

Post Test							
Post Test Measures	**Group**	**Mean**	**SD**	**Mean difference**	**Mann whitney U test**	**Z**	**P-value**
MAS-Post	Experimental	0.07	0.26	-0.46	60.00	-2.74	**0.006**
	Control	0.53	0.52				
MST Affected-Post	Experimental	172.00	14.24	29.33	42.50	-2.95	**0.003**
	Control	142.67	26.58				
MST Unaffected-Post	Experimental	212.67	35.55	34.67	61.500	-2.13	**0.033**
	Control	178.00	40.92				
BI-Post	Experimental	89.33	3.72	9.33	22.00	-3.86	**0.000**
	Control	80.00	5.35				

Graph- 12: Graphical representation of comparison of post-values of MAS between Experimental and Control groups



- **Interpretation:** In the post-test assessment of muscle spasticity using the Modified Ashworth Scale (MAS-Post), a significant difference was identified between the groups. The experimental

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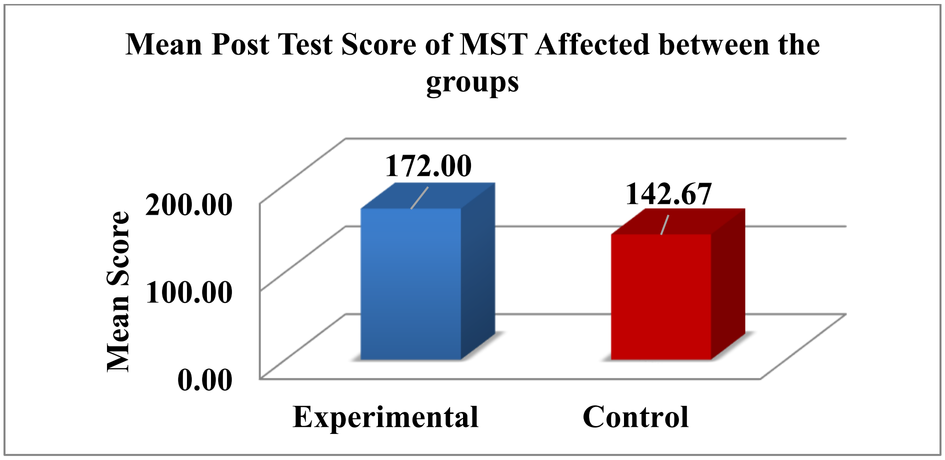
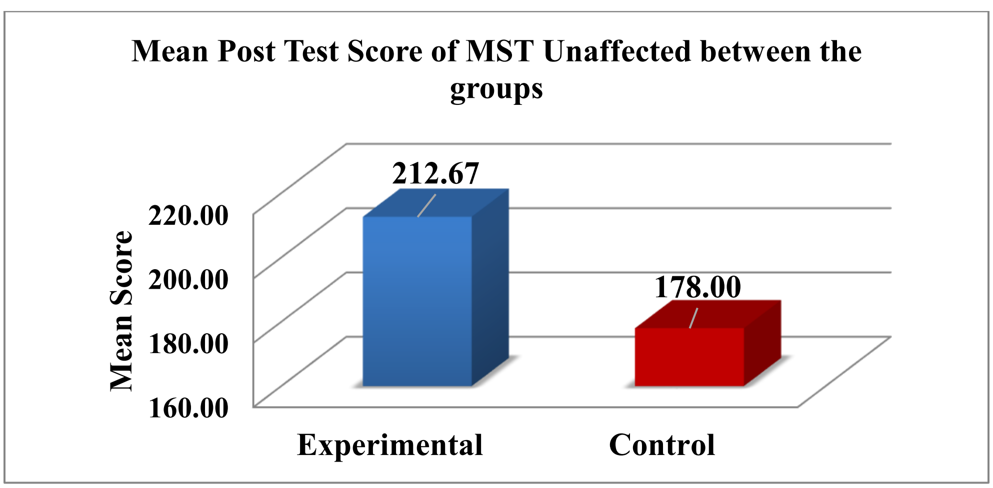
group exhibited a lower mean score of 0.07 compared to 0.53 in the control group. This difference was statistically significant, as indicated by a Mann-Whitney U test result of Z = –2.74 and a p-value of 0.006. These findings demonstrated that the experimental group experienced a greater reduction in muscle spasticity following the intervention.

Graph- 13: Graphical representation of comparison of post-values of MST of affected hand between Experimental and Control groups



- **Interpretation:** In the post-test assessment of motor function on the affected limb (MST Affected-Post), the experimental group showed a higher mean score of 172.00 compared to 142.67 in the control group. This difference was statistically significant (Z = –2.95, p = 0.003), indicating greater improvements in voluntary motor control following the intervention. The results reflected the positive effect of task-oriented strength training on neuromuscular recovery in individuals with sub-acute stroke.

Graph- 14: Graphical representation of comparison of post-values of MST of Unaffected hand between Experimental and Control groups



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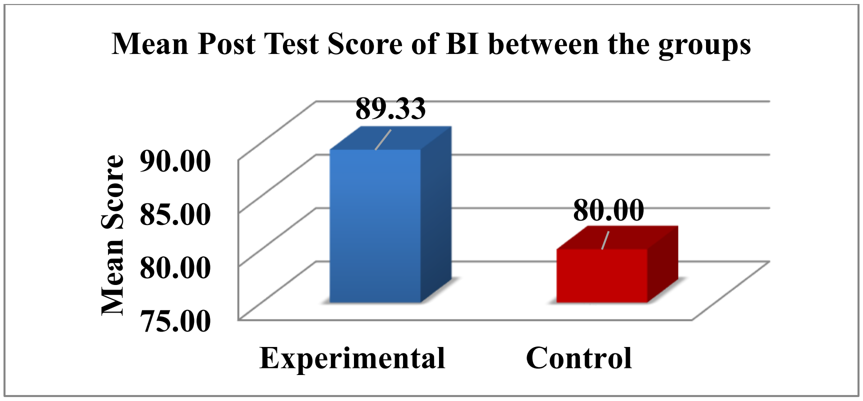
- **Interpretation:** In the post-test grip strength assessment of the unaffected limb, the experimental group showed a significantly higher mean score (212.67) than the control group (178.00), with a Z-value of –2.13 and p = 0.033. This indicated a significant improvement in motor performance on the unaffected side, likely due to enhanced neuromuscular coordination and bilateral involvement from task-oriented strength training.

Graph- 15: Graphical representation of comparison of post-values of BI between Experimental and Control groups.



Interpretation:
Post-intervention, the experimental group showed significantly higher Barthel Index scores (89.33 vs. 80.00; Z = –3.86, p = 0.000), indicating greater improvement in functional independence. This supports the effectiveness of task-oriented strength training in enhancing daily living skills in sub-acute stroke patients.

Summary:
Both within- and between-group analyses confirmed that task-oriented strength training led to significantly greater improvements in upper limb recovery, including reduced spasticity, improved grip strength, and enhanced daily function. While the control group showed moderate gains, the experimental group consistently outperformed, reinforcing the value of task-oriented training in stroke rehabilitation.

9. DISCUSSION:

This study aimed to evaluate the effect of task-oriented strength training (TOST) on upper limb spasticity, grip strength, and activities of daily living (ADLs) in individuals with sub-acute stroke. Thirty participants were randomly assigned to an experimental group (TOST + conventional therapy) or a control group (home exercises + conventional therapy) for six weeks.

Both groups showed statistically significant improvements in all outcome measures; however, the experimental group demonstrated significantly greater gains in reducing spasticity, improving grip strength, and enhancing ADLs.

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Spasticity, measured by MAS, significantly decreased in the experimental group (from 1.80 ± 0.41 to 0.07 ± 0.26, $p = 0.000$). These improvements are attributed to TOST's ability to promote neuroplasticity, motor relearning, and reflex modulation through purposeful task engagement. Similar findings were reported by Patel & Kanase (2021) and Hui Dang et al. (2019), supporting the effectiveness of task-oriented approaches.

The control group also showed a reduction in spasticity (from 1.47 ± 0.52 to 0.53 ± 0.52), likely due to electrical stimulation, stretching, and ROM exercises.

In terms of grip strength, the experimental group improved from 105.33 ± 14.94 to 172.00 ± 14.24 ($p = 0.001$), while the control group improved from 111.33 ± 24.01 to 142.67 ± 26.58. TOST likely enhanced motor unit recruitment, muscle coordination, and strength through repetitive, functional resistance training. These results align with previous studies by Chaitali Mali et al. (2023).

Regarding ADLs, the experimental group showed significant improvement in Barthel Index scores (from 75.00 ± 3.78 to 89.33 ± 3.72, $p = 0.000$), reflecting better functional independence. This is supported by prior studies, including Patel & Kanase (2021) and Sakina Katerawala et al. (2019). The control group also improved, likely due to neuromuscular re-education from conventional therapy

In conclusion, while both interventions were effective, TOST combined with conventional therapy produced significantly superior outcomes. These findings support integrating TOST into stroke rehabilitation programs to enhance functional recovery, grip strength, and daily independence in sub-acute stroke patients.

CONCLUSION

The present study concluded that task-oriented strength training along with conventional treatment was found to be more effective compared to Conventional treatment alone on upper limb spasticity, grip strength, and activities of daily living in subjects with sub-acute stroke

LIMITATIONS AND RECOMMENDATIONS

- The inclusion of only sub-acute stroke patients limits the applicability of results to acute or chronic stroke populations.
- Future studies should include larger, more diverse populations to improve generalizability across stroke demographics.
- Long-term follow-up is recommended to assess retention of functional gains and determine the sustainability of the combined intervention.
- Studies comparing TOST + ES with **o**ther advanced neurorehabilitation techniques (e.g., robotic therapy, mirror therapy) may help refine stroke rehabilitation protocols.
- Including neuroimaging or electrophysiological measures could provide deeper insights into cortical changes and mechanisms of recovery.
- Exploring the impact of task-oriented strength training in home-based or telerehabilitation settings can expand accessibility and clinical applicability.

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