To Examine the Effects of Early Cognitive and Physical Training on Enhancing the Cognition of Stroke Patients

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Abstract

Stroke is a leading cause of disability worldwide, often resulting in significant cognitive and physical impairments that hinder daily functioning and quality of life. Cognitive deficits, including memory, attention, and executive function impairments, are common in stroke patients, impacting their ability to regain independence. This study aimed to evaluate the impact of combined cognitive and physical training on the cognitive abilities of stroke patients. A total of 30 mild stroke patients, aged 47–67 years, were randomly assigned into two groups: an experimental group (n=15) receiving combined cognitive and physical training, and a control group (n=15) with no such intervention. Participants were selected from Jaipur Occupational Therapy College, India, using random sampling. Cognitive assessments, including the Montreal Cognitive Assessment (MOCA) and Mini-Mental State Examination (MMSE), were conducted pre- and post-training. Results showed significant improvements in the experimental group, with post-training MOCA scores ranging from 26 to 29 and MMSE scores from 24 to 27, indicating normalization of cognitive abilities. Early combined interventions demonstrated measurable enhancements in cognitive function, reduced impairment, and improved quality of life. These findings highlight the importance of integrated cognitive and physical training for early-stage stroke rehabilitation, emphasizing its potential to restore function and reduce complications.

Keywords: stroke rehabilitation, cognitive training, physical training, cognitive abilities, early intervention, quality of life, mild stroke, MOCA, MMSE.

I. Introduction

Stroke remains one of the leading causes of disability worldwide [1, 2]. Cognitive impairments in stroke patients are prevalent, affecting 20%–80% of cases and persisting in 38%–73% of patients [3–5]. These impairments can impact various domains, including concentration, memory, learning, planning, problem-solving, and the ability to initiate or stop activities. Stroke-related cognitive deficits often encompass attention, memory, language, executive function, spatial perception, aphasia, apraxia, agnosia, dyslexia, and visual-spatial orientation [5]. Such impairments may become the predominant clinical feature in many cases, with approximately 74% of cortical stroke patients, 46% of subcortical stroke patients, and 43% of infratentorial stroke patients exhibiting cognitive deficits [6, 7]. These deficits can delay recovery, complicate rehabilitation, and adversely affect prognosis [2].

Stroke is the third-leading cause of disability-adjusted life years (DALYs) worldwide [1]. Post-stroke motor and cognitive impairments are common, with one-fifth of patients experiencing significant disability three months post-stroke, despite initial improvements during the "golden period" of recovery [2, 3]. Early, scientifically grounded rehabilitation interventions can enhance brain function and improve long-term outcomes by leveraging this critical recovery window [3].

Effective rehabilitation programs should involve repetitive, intensive task-based exercises tailored to individual patient needs and tolerance. Early initiation of such interventions reduces the risk of recurrent strokes and improves functional outcomes [5]. Cognitive impairments not only increase disability but also indirectly hinder functional recovery by reducing participation in rehabilitation programs and adherence to treatment guidelines. Furthermore, cognitive decline correlates with poorer performance in activities of daily living (ADL) and diminished quality of life [6].

While evidence supports early motor rehabilitation after stroke, research on early cognitive rehabilitation remains limited. Cognitive rehabilitation focuses on training and teaching compensatory strategies to foster adaptation to the environment, offering potential benefits for cognitive recovery. However, due to the heterogeneity of post-stroke cognitive impairments, treatment protocols remain inconsistent. Key questions regarding the type, timing, duration, and intensity of interventions, as well as outcome measures, are yet to be resolved. Consequently, cognitive rehabilitation has not been fully integrated into standard stroke care [7, 8].

Post-stroke cognitive impairments (PSCI) increase institutionalization rates and care costs while significantly reducing patients' quality of life [8–10]. Despite the widespread use of neuropsychological tools like the Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) to assess cognitive deficits [11], comprehensive clinical guidelines for addressing cognitive rehabilitation across all domains remain unavailable.

Recent studies suggest that combining physical exercise with cognitive training may represent a promising approach for enhancing cognitive function after stroke, though research in this area is limited. A systematic review highlights the growing focus on cognitive training but emphasizes the need for higher-quality studies to establish evidence-based clinical recommendations [14]. Notably, few studies have evaluated the impact of combined dual-task training on cognitive recovery in stroke patients. This study seeks to investigate changes in cognitive abilities following an intervention that integrates physical and cognitive training [10].

1.1 Rationale of the Study

This study aims to fill a critical gap in the literature by evaluating the effects of a combined physical and cognitive training intervention on cognitive recovery in stroke patients. By exploring this innovative approach, the study seeks to provide insights into effective strategies for cognitive rehabilitation, inform clinical practice, and ultimately contribute to improving the quality of life for stroke survivors.

II. Aim and Objectives

AIM & OBJECTIVE OF THE STUDY

AIM:

To study the effect of early training cognitive and physical improves cognition in stroke patients

OBJECTIVE:

- To see the change in cognitive abilities after giving combined cognitive and physical training in stroke cases.
- Changes occur more when in combined physical and cognitive training in cognitive function of stroke patients.

2.1 HYPOTHESIS

Null- Hypothesis (H_0)

Early dual task cognitive and physical training does not show any improvement in cognition abilities of mild stroke patient.

Alternate Hypothesis (H_1)

Early dual task cognitive and physical training shows improvement in cognition in mild stroke patients.

III. Research Methodology

3.1 Sample design - Experimental

3.2 Source of data - Jaipur Occupational Therapy College, India

Participants - Convenient sample of 30 People age range from 47 to 67years. They randomly assigned into one of two group, group I used as experimental group (15 stroke patients) and group II used as a control group (15 stroke patients) using closed envelop with hemiplegic side brunnstrom stage is 4-6.

3.3 Sample size - A total of 30 eligible participants for participation in the study

3.4 Sampling technique – Randomly selected

Age group – 47<66

Inclusion Criteria

- Stroke with age group pf 47 years to 67 years
- Mild cognitive impairment
- Acute phase 3 to 30 days of stroke
- First episode of stroke
- Patient with other medical condition should be stable

Exclusion Criteria

- No haemorrhagic stroke
- No moderate and severe infarct
- No recurrent episodic stroke
- No subacute and chronic stroke
- Patients having aphasia or mutism state will not include in the study
- No severe diabetic and other predisposing factors

3.5 Outcome Measures or scales used

MOCA - Montreal Cognitive Assessment (MoCA) is a rapid screening instrument for mild cognitive dysfunction. It assesses different cognitive domains: attention and concentration, executive functions, memory, language, visuo-constructional skills, conceptual thinking, calculations, and orientation.

Give one point for each item correctly answered

No points are allocated if subject makes an error of one day for the day and date
The maximum score is 30, therefore, if a subject scores 30/30, means no cognitive deficit is present.

- 18-25 = mild cognitive impairment,
- 10-17= moderate cognitive impairment
- 10 or less = severe cognitive impairment.

MMSE - The MMSE is a 30-point test used to measure thinking ability or cognitive impairment.
The test measures the following:

1. Orientation to time and place (knowing where you are, and the season or day of the week)
2. Short-term memory (recall)
3. Attention and ability to solve problems (like spelling a simple word backwards)
4. Language (identifying common objects by name)
5. comprehension and motor skills (drawing a slightly complicated shape like two pentagons intersecting)

- 24 and higher = Normal cognition; no dementia
- 19 – 23 = Mild dementia
- 10 – 18 = Moderate dementia
- 9 and lower = Severe dementia

3.6 Materials required

MMSE scale, MOCA scale, pen, paper, assessment Performa, ball, numeric cards, beans, and puzzles.

3.7 Procedure

We collected the data from Pacific Hospital, Udaipur on the basis of inclusion and exclusion criteria on a randomised sample design 15 patients were allocated in the experimental group and 15 patients in control group of mild stroke cases with mild cognitive impairment of age group lies between 47 to 67years old. The assessment will be done according to MOCA and MMSE scale. In experiment group we give combined training for 45 min/each time twice daily for 4 weeks treatment and control group will receive conventional treatment. Reassessment after intervention will be taken and check statistically.

Treatment

Cognitive and physical treatment has been given for the duration of 45 min/each time twice daily for 4 weeks.

Dual-task training programs include practicing counting forward and backward while stepping and searching for alphabet in a sheet while strengthening the quadriceps with isometric exercise. The therapist will take 5 minutes to explain the protocol, last 5 min of cool down and 35 minutes of task each time and 5 mins each

- Attention: Patient has to do reaching activity from hand at various level which includes attention, focus tracking and motivation 20 times at one time, ask the patient to throw a ball from overhead to two meters in basket at low level or pick beans from hand count backward with one minus.
- Orientation: Give him a pamphlet to tick for the correct date, time, day, place and location and ask the patient to touch various parts of the body on command of therapist with his hand 20 times in each session, also ask the patient to roll over the bed and take the thing of his interest to reach in different direction while rolling
- Calculation: Put circle and numbers on the floor like 100-9 for 3 consecutive times and scattered the result then tell the patient to walk on correct answers repeat 5 each time
- Memory: Includes telling a story to the patient with balance training activity and ask him to recall after finish; Story narration, remembering words, reading to newspaper and ask him to write the heading.
- Language training: through repeated listening, reading, retelling stories and information, asking questions and discussing topics of interest to patients, so as to train their verbal expression and logical thinking skills (12) with hand function for 5 minutes.
- Training the ability to solve problems: arrange things related to daily life and let the patient complete it independently, such as eating after washing, ask the patient to find the pen and pencil from the clutter needs physical movement, find the puzzle placed at different areas of room.
- Abstract Thinking: Ask the patient construct a building with 30 blocks, role playing, and picture description.

IV. Data Analysis

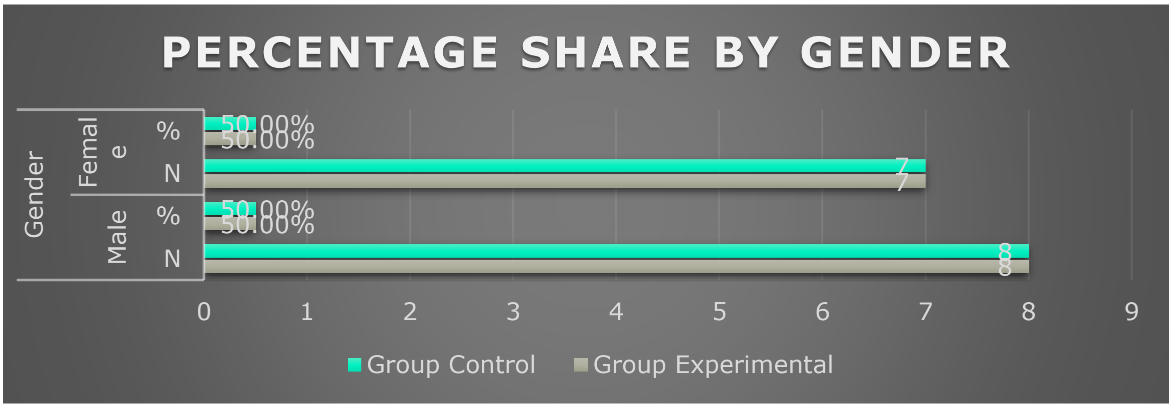
This scale is used to assess the cognitive level of the patient in mild stroke patient in which orientation, memory, problem solving skills, logical reasoning has to assessed in patient

Gender will play equal role in the as equal number of male and female were participated and average of 50% male and 50% female in the study

Table: 1 Relationship between experimental and control with respect to gender

Descriptive statistics

		Gender			
		Male		Female	
		N	%	N	%
Group	Experimental	8	50.00%	7	50.00%
	Control	8	50.00%	7	50.00%

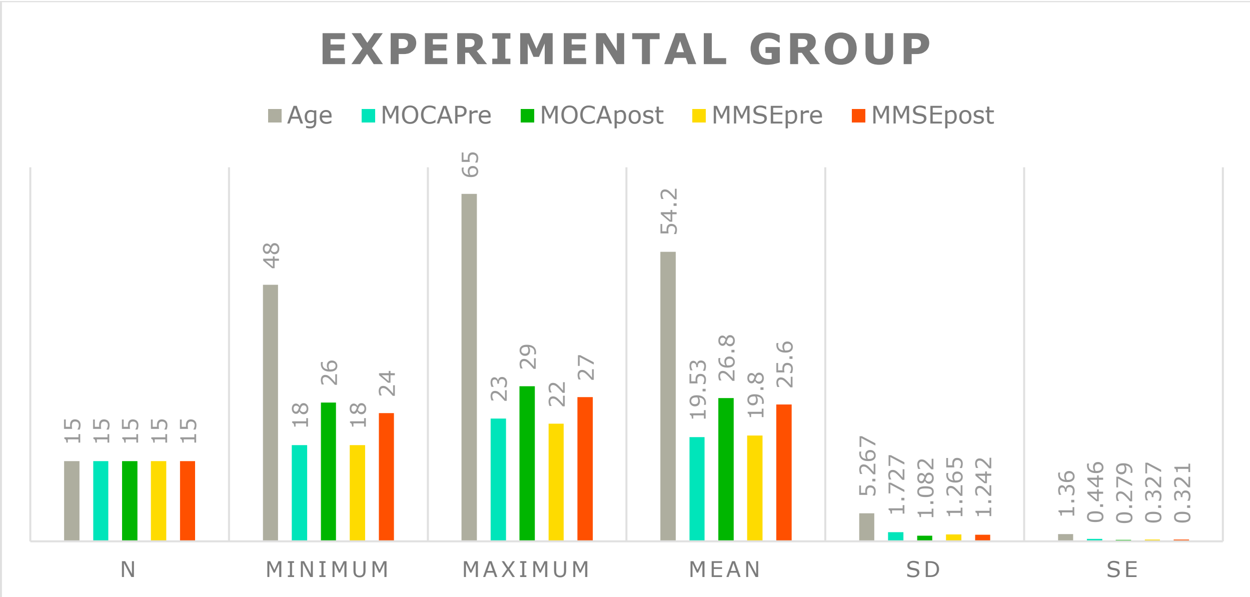


The above figure displays, the percentage share of respondents by gender. The orange colour represents the control group male and female and the blue colour represents experimental group male and female in the study and gender play. 50% of males are there in control group and 50% of females in control group same as in experimental group. Therefore, gender plays equal role in the study

Table 2: Relation between experimental group regarding their Montreal Cognitive Assessment Scale (MOCA) and Mini Mental State Examination, (MMSE) in pre and post-test scoring result.

Descriptive:

Experimental group	N	Minimum	Maximum	Mean	SD	SE
Age	15	48	65	54.2	5.267	1.36
MOCAPre	15	18	23	19.53	1.727	0.446
MOCApost	15	26	29	26.8	1.082	0.279
MMSEpre	15	18	22	19.8	1.265	0.327
MMSEpost	15	24	27	25.6	1.242	0.321

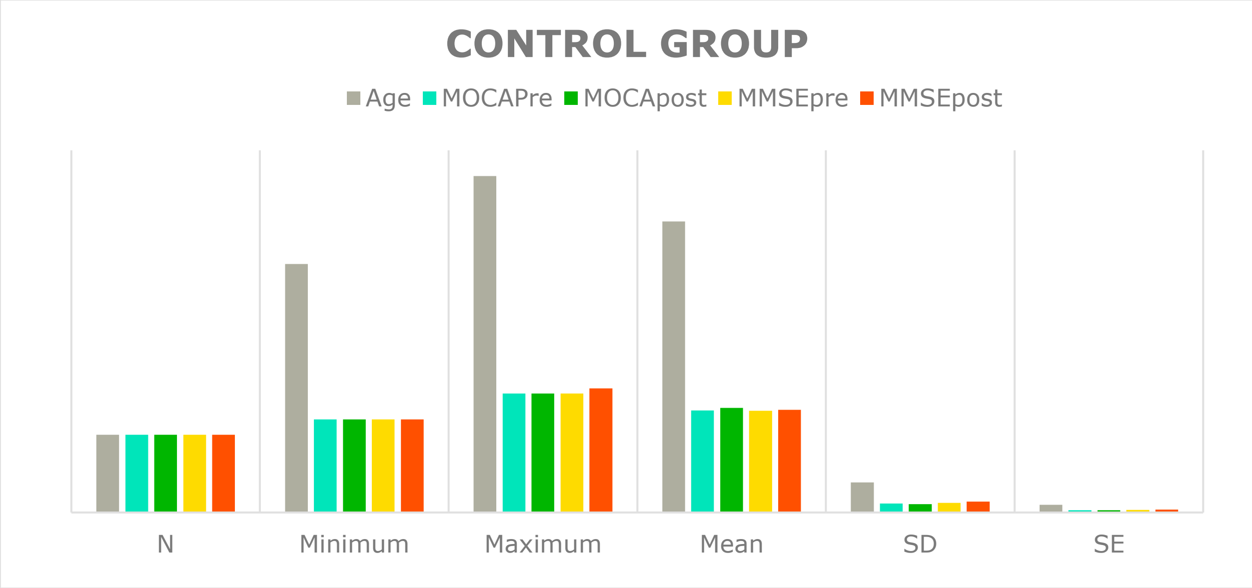


The above table shows that there is increase in values of MOCA and MMSE in post training scores while compare to pre training. It has been proven from the graph that there is significant changes in post training score of both the scales as cognitive abilities improve after given cognitive and physical training in mild stroke cases as they range above the score of 26 which is the normal cognitive level of the scale.

Table 3: Relation between control group regarding their Montreal Cognitive Assessment Scale (MOCA) and Mini Mental State Examination, (MMSE) in pre and post-test scoring result.

Descriptive:

Control Group	N	Minimum	Maximum	Mean	SD	SE
Age	15	48	65	56.27	5.8	1.498
MOCAPre	15	18	23	19.73	1.71	0.441
MOCApost	15	18	23	20.2	1.612	0.416
MMSEpre	15	18	23	19.67	1.877	0.485
MMSEpost	15	18	24	19.87	2.134	0.551

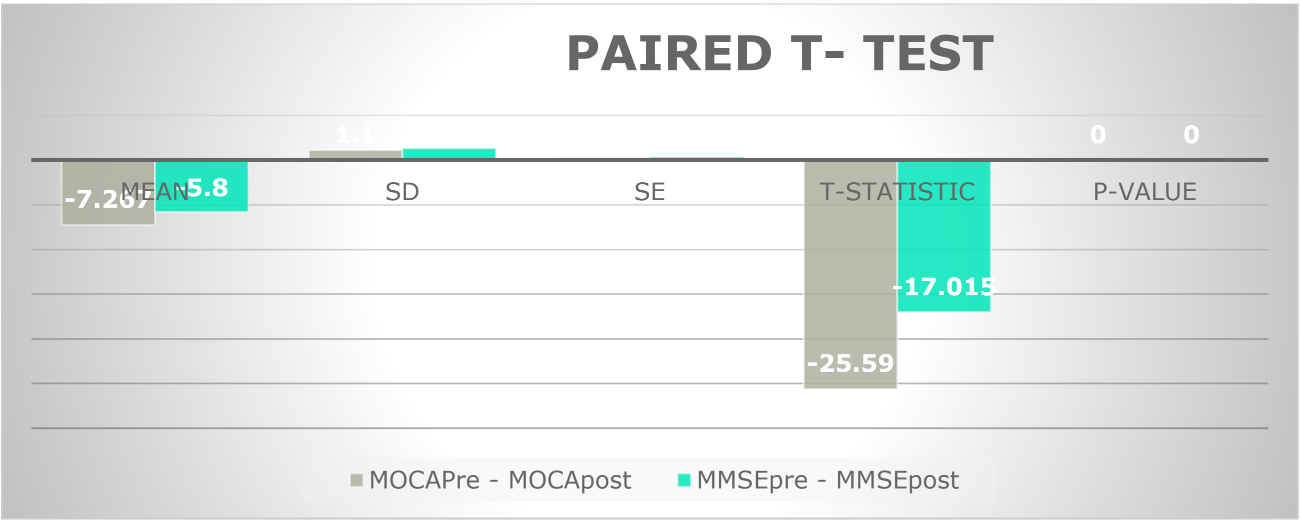


The above table shows that there is slight increase in values of MOCA and MMSE in post training scores while compare to pre training with the other treatment but from the graph that there is no significant changes in post training score of both the scales as cognitive abilities are still in mild cognitive states as the scorings are 23 after the normal treatment in control group.

Table 4: Determine if there is significant difference between the means of two dependent sample

Paired-t test:

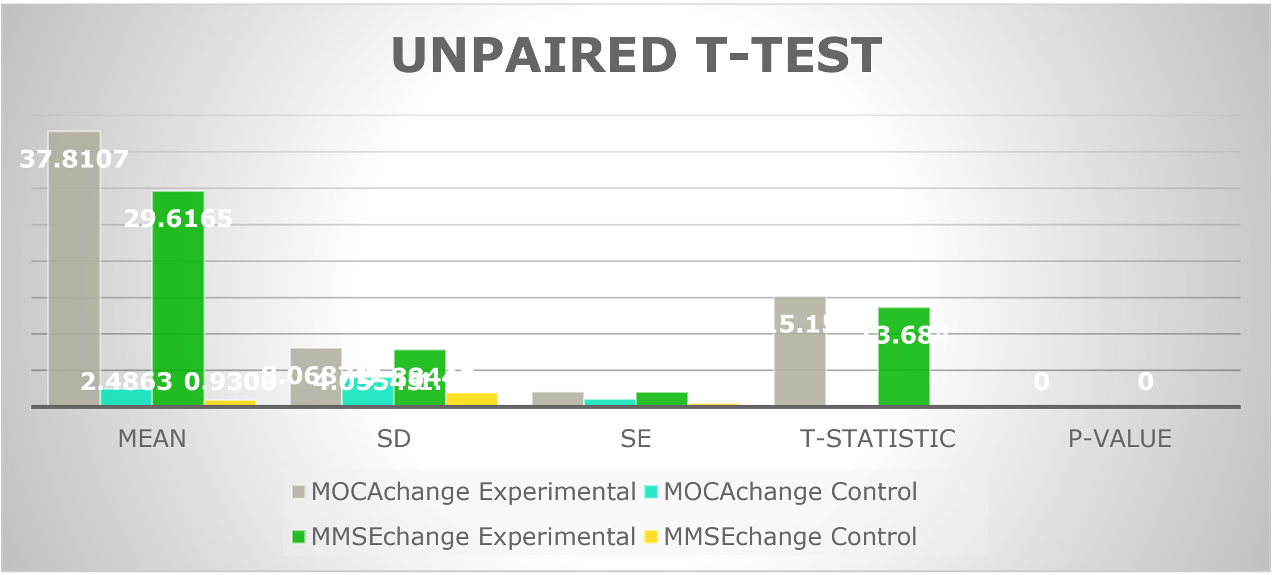
Experimental Group	Mean	SD	SE	t-statistic	p-value
MOCAPre - MOCApost	-7.267	1.1	0.284	-25.59	0.001*
MMSEpre - MMSEpost	-5.8	1.32	0.341	-17.015	0.001*



In the above graph it is shown that there difference present between the means of two dependent variable MOCA and MMSE scale when assessing for the post training intervention for cognitive abilities in stroke patients.

Table 5: Unpaired t test to determine if there is a significant difference between the means of two independent variables

Unpaired-t test	Group	Mean	SD	SE	t-statistic	p-value
MOCAchange	Experimental	37.8107	8.06871	2.08333	15.15	0.001*
	Control	2.4863	4.05545	1.04711		
MMSEchange	Experimental	29.6165	7.88445	2.03576	13.684	0.001*
	Control	0.9306	1.93683	0.50009		



In this figure two independent variables are checking for the change in the mean values you can see the change in both the scales in experimental group where we are giving treatment for cognitive abilities are higher than the control group. Hence proven that the cognitive abilities improve after early cognitive and physical intervention in the stroke cases.

V. Results

The study utilized the Montreal Cognitive Assessment Scale (MOCA) and the Mini Mental State Examination (MMSE) to evaluate cognitive abilities in mild stroke patients, focusing on orientation, memory, problem-solving skills, and logical reasoning. Gender representation was balanced, with equal participation from males and females (50% each in both experimental and control groups), ensuring unbiased gender influence on outcomes.

In the experimental group, a significant improvement was observed in cognitive abilities post-intervention. The MOCA scores increased from a mean of 19.53 (SD = 1.727) in the pre-test to 26.8 (SD = 1.082) in the post-test. Similarly, MMSE scores improved from a mean of 19.8 (SD = 1.265) in the pre-test to 25.6 (SD = 1.242) post-test. These scores surpassed the normal cognitive threshold of 26, indicating enhanced cognitive functioning after cognitive and physical training.

In contrast, the control group showed minimal improvement. The MOCA scores increased marginally from a mean of 19.73 (SD = 1.71) to 20.2 (SD = 1.612), while MMSE scores rose slightly from 19.67 (SD = 1.877) to 19.87 (SD = 2.134), remaining below the normal cognitive level. This suggests limited efficacy of the alternative treatment provided to this group.

Statistical analysis further supported these findings. A paired t-test for the experimental group revealed significant differences between pre- and post-training scores for MOCA ($t = -25.59$, $p = 0.001$) and MMSE ($t = -17.015$, $p = 0.001$). Similarly, an unpaired t-test comparing the experimental and control groups demonstrated significant differences in cognitive improvements, with the experimental group showing markedly higher changes in MOCA ($t = 15.15$, $p = 0.001$) and MMSE ($t = 13.684$, $p = 0.001$).

These results confirm that early cognitive and physical interventions significantly enhance cognitive abilities in mild stroke patients, compared to standard treatments in the control group.

VI. Discussion

Montreal Cognitive Assessment Scale (MOCA) and Mini Mental State Examination (MMSE), the study effectively captured the cognitive changes in patients, specifically assessing orientation, memory, problem-solving, and logical reasoning.

A key strength of the study was the balanced gender representation, with equal participation from males and females in both the experimental and control groups. This ensured that gender did not bias the results, providing a robust foundation for interpreting the effects of the intervention.

The significant improvement in the experimental group's cognitive scores highlights the potential of structured cognitive and physical training programs. MOCA scores in the experimental group increased substantially from 19.53 to 26.8, while MMSE scores rose from 19.8 to 25.6, both surpassing the normal cognitive threshold of 26. This underscores the role of early interventions in restoring or enhancing cognitive functions post-stroke. Conversely, the control group showed only marginal improvements, with scores remaining below the normal cognitive threshold, suggesting that standard care alone may be insufficient for optimal recovery in such patients.

Statistical analyses reinforced these findings. The paired t-test results indicated significant improvements in both MOCA and MMSE scores within the experimental group, while the unpaired t-test demonstrated a clear disparity in cognitive gains between the experimental and control groups. These results collectively validate the hypothesis that structured cognitive and physical interventions outperform standard treatments in enhancing cognitive recovery post-stroke.

The study's results align with existing literature that emphasizes the neuroplasticity of the brain and its responsiveness to targeted interventions. Early cognitive and physical rehabilitation programs stimulate neural pathways, promoting recovery and functional improvement. However, the limited improvement in the control group suggests that conventional treatment approaches may fail to capitalize on this potential, leaving cognitive impairments inadequately addressed.

Despite these positive outcomes, the study has certain limitations. The sample size was relatively small, which might limit the generalizability of the findings. Additionally, the study focused on mild stroke patients, and the results may not extend to individuals with moderate or severe cognitive impairments. Future research with larger, more diverse populations and longer follow-up periods is warranted to confirm these findings and explore the sustainability of cognitive improvements.

VII. Conclusion

In conclusion, this study provides compelling evidence that early cognitive and physical interventions significantly enhance cognitive abilities in mild stroke patients. These findings advocate for the integration of such programs into routine post-stroke care, potentially transforming recovery trajectories and improving the quality of life for stroke survivors.

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