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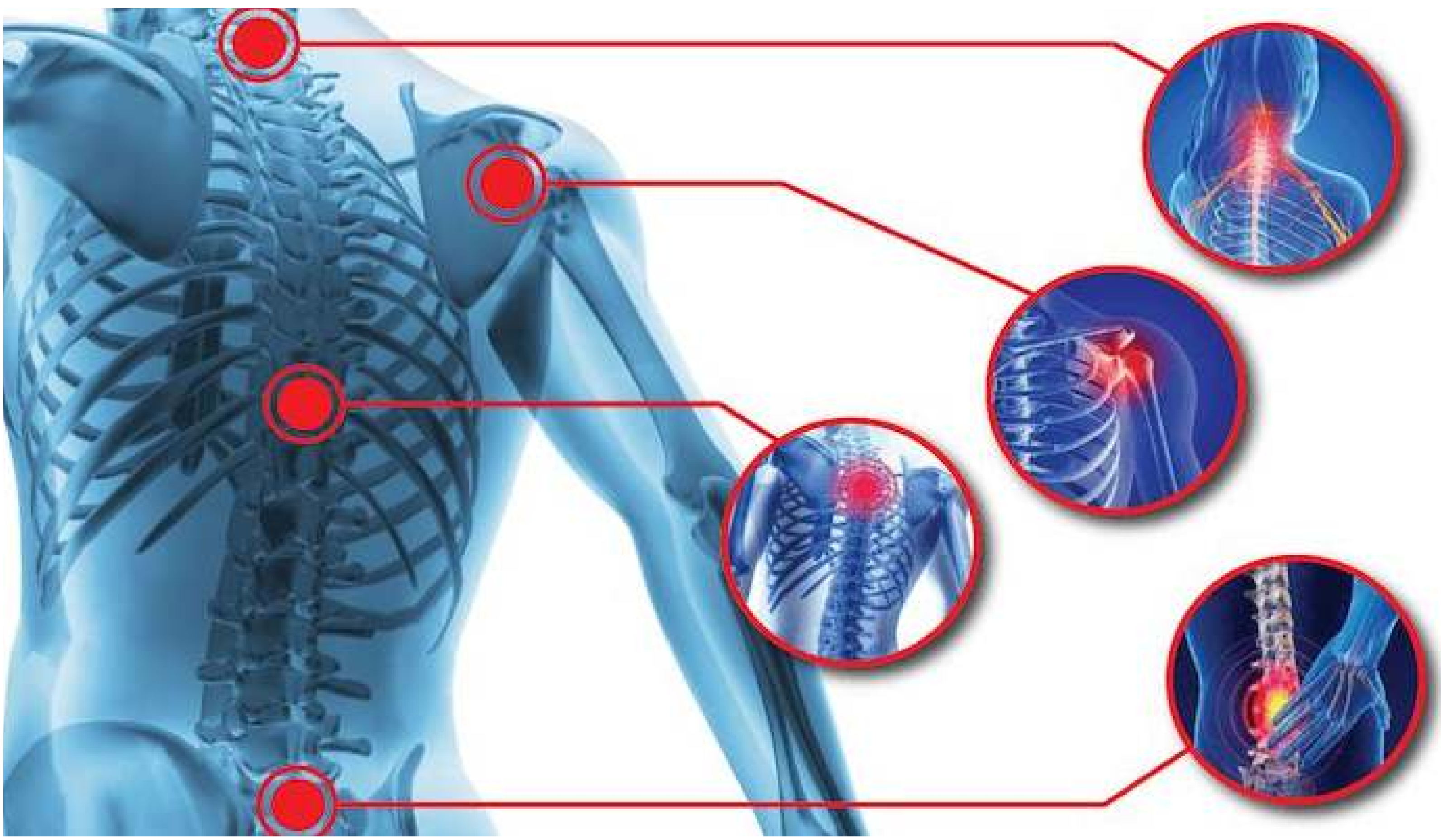

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EFFECT OF INTENSIVE COGNITIVE TRAINING ON COGNITION AND FUNCTIONAL STATUS IN ACUTE STROKE PATIENTS WITH POST STROKE COGNITIVE IMPAIRMENT – A QUASI-EXPERIMENTAL STUDY

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ABSTRACT

*Background**:** Stroke is the second leading cause of death and a major contributor to disability worldwide. The blood supply to the brain is controlled by two internal carotid arteries anteriorly and two vertebral arteries posteriorly. Ischemic stroke is caused by the deficiency of blood and oxygen supply to the brain. Haemorrhagic stroke is caused by bleeding or punctured blood vessels.*

*AIM**:** The aim of the study is to investigate the effect of intensive cognitive training on cognition and functional status in acute stroke patients with post stroke cognitive impairment.*

*Methodology**:** Two groups were taken including the experimental group which received Intensive cognitive functional training combined with routine rehabilitation training and control group which received routine rehabilitation training. A minimum of 30 patients were recruited for the study and were divided into two groups, the total protocol duration was of 3 weeks. The patient received two training sessions twice a day, for 60 minutes. Outcome measures included Modified Barthel Index (MBI) and Montreal cognitive assessment (MoCA).*

*Results**:** The results of the study showed that there was statistically significant difference in Control Group A and Experimental Group B. Therefore, the Experimental Group showed greater improvement for outcome measure MoCA and MBI as compared to Control Group.*

*Conclusion**:** In conclusion, intensive cognitive training appears to enhance cognitive function in acute stroke patients with PSCI, with significant effects observed by the 21st day. These findings highlight the importance of structured cognitive rehabilitation in stroke recovery.*

Keywords: Cognitive training, Rehabilitation, Stroke.

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1. INTRODUCTION

Stroke (cerebrovascular accident [CVA]) is the sudden loss of neurological function caused by an interruption of the blood flow to the brain.[1] A direct result of the nation's aging population is a sharp increase in the prevalence of cardiovascular and cerebrovascular illnesses, particularly stroke, which is becoming more common. The first three months following the commencement of a stroke are considered the "golden period" for reducing the rate of disability, based on epidemiological studies.[2]. It can be broadly divided into two types: ischemic stroke and haemorrhagic stroke, which includes subarachnoid haemorrhage and intracerebral haemorrhage. **Transient ischemic attack (TIA):** When there is a temporary disruption in blood flow, it can result in a transient ischemic attack (TIA), which passes before inflicting long-term harm.[3] **Ischemic stroke:** It is caused by deficiency of blood and oxygen supply to the brain. In stroke patients, ischemic occlusions account for about 85% of deaths. In the brain, ischemic occlusion causes thrombotic and embolic situations. **Haemorrhagic stroke:** It is caused by bleeding or punctured blood vessels. Hemorrhagic stroke accounts for approximately 10–15% of all strokes and has a high mortality rate.[4] Every year, 15 million individuals worldwide suffer from strokes, with roughly 30% of those victims having long-lasting disability.[5] The somatosensory system processes and reflects a variety of somatic sensation modalities, including touch, pain, temperature, and proprioception. When the motor cortex is injured, the brain attempts to maintain motor control by rearranging sensorimotor interactions. This process involves the recruitment of primary sensory cortices, secondary motor areas, and higher-order association areas.[6] All varieties of cognitive impairments can be included in dementia following a stroke injury. Numerous factors contribute to the risk of cognitive impairment and dementia following a stroke, such as advanced age, genetic variations, family history, low educational attainment, vascular comorbidities, previous transient ischemic attack or recurrent stroke, and mental disorder.[7] Acute cognitive problems have been shown to be strong indicators of depression symptoms, long-term cognitive impairment, and reliance on both simpler and more complex activities of daily living.[8] Cognitive impairment affects about two thirds of stroke patients during the acute phase and 69.8–96% of patients in the three–six months that follow the start.[9] About 10–15% of all strokes in young people happen to adults between the ages of 25 and 49.[10] Cognitive behavioral therapy is a type of psychotherapy that helps patients build self-confidence and coping skills by rerouting negative cognitive, emotional, or behavioral reactions.[11] The degree of participation, integration, and quality of life are reduced in subjects who have had a stroke-based episode due to a wide and varied range of physical, cognitive, emotional, and behavioral issues as well as functional challenges in daily living activities. It has been shown to improve gait, postural balance, trunk balance, strength, spasticity, upper limb motor function, as well as cognitive level and attention, among other areas.[12] Occupational therapy, physical therapy, self-rehabilitation, assistive devices and orthoses, medication, orthopedic surgery, and neurosurgery are examples of therapeutic interventions.[13] Sudden, usually unilateral, motor impairment, affecting movement of the face, arms, and legs on one side of the body, along with potential numbness, is the most prevalent symptom of stroke. As a result, those who have had a chronic stroke have mobility deficits, which include poor standing, slowed walking, trouble balancing, and a higher risk of falling. Because of this, a large portion of stroke therapy, especially for physical therapists, focuses on helping patients regain their physical independence and functional capacity during activities of daily living (ADL), including walking, balancing, and upper and lower limb movement. Exercise regimens, such as functional training, individual or group therapy, or disability-based treatments, form its primary foundation. These programs typically include exercises and tasks on unstable surfaces, strengthening activities, and various sensory-motor challenges that help participants build useful coping mechanisms for ADLs. It enables therapists to create rehabilitation plans that improve adherence to intervention by enhancing the neurobiological principles of brain plasticity: task-oriented, intense, and repetitive exercises in stimulating settings.[14] Cognitive training, cognitive rehabilitation, and cognitive stimulation are the three main subcategories of cognitive remediation therapies, which focus on cognitive decline. Restorative techniques are used in cognitive training to enhance cognitive function.[15]

2. METHODOLOGY

The patients meeting the inclusion criteria and who had given consent to participate were recruited for the study. 30 patients with acute ischemic stroke and hemiparesis were selected for this study. Inclusion criteria: a) Both genders were included between 40-65 years of age b) ability to read and write, c) Stable vital signs, and symptoms of ischemic stroke no longer progressing for more than 2 days. d) Subjects with Glasgow Coma Scale score between 13-15 and e) Patients with score less than 23 on Mini-Mental State Examination. Exclusion Criteria: a) Patients with speech deficit, b) Dementia being diagnosed by a doctor prior to stroke onset c) Previous history of mental retardation and illness d) Severe visual or hearing impairment e) Paretic dominant hand f) Having a malignant disease with life expectancy of <6 months. Two groups were taken including Experimental Group (Group B) which underwent intensive cognitive functional training combined with routine rehabilitation training and Control Group (Group A) which underwent routine rehabilitation training alone. The Mini-Mental State Examination (MMSE) and Glasgow coma scale (GCS) were used to evaluate cognitive function. The Montreal Cognitive Assessment Scale (MoCA) and the Modified Barthel Index (MBI) were used at each time point to measure the functional outcomes of the patients.

ONTROL GROUP: The patients received routine rehabilitation training from the third day of admission twice a day. The treatment duration was of 60 minutes. Each exercise was performed for 10 repetitions, one set, five times a week for 3 weeks. i) Passive and active joint range of motion exercise ii) Turning exercises from the healthy side to the affected side iii) Sitting balance training iv) Sit to stand training v) Standing balance training

Fig. 1: Routine Rehabilitation Training

EXPERIMENTAL GROUP: Cognitive function training combined with routine rehabilitation training check twice a day, 60 min/session time, and 3 weeks in total. a) Orientation training b) Attention training c) Calculation training exercises d) Memory training e) Language training f) Training for the ability to solve problems.

Fig. 2: Cognition functional training (Alphabets, Numbers and geometric Shape Blocks Counting Boards)

3. RESULTS

This chapter deals with the analysis and interpretation of data collected. The data was analysed by calculating the score in terms of frequency, percentage, mean, standard deviation, chi-square, etc. Repeated Measures ANOVA was used for within the group analysis. Independent t-test was used for between the group analysis. The level of significance chosen was at $p \leq 0.05$. Analysis and interpretation were done in accordance with the objectives laid down for the study. Data was analyzed using SPSS version 18.0.

From the provided data, we can interpret the results of the unpaired t-test comparing the ages of Group A and Group B. The mean age for Group A is 58.73 years with a standard deviation of 5.625, while the mean age for Group B is 57.00 years with a standard deviation of 6.897. Both groups have 15 individuals as show in table 1.

Table 1. Demographic characteristics of the patients

	GA(n-15)	GB(n-15)	p value
Gender(M/F)	12/3	11/4	
Age(year)	58.73±5.625	57±6.897	0.457

Values represented as Mean±SD, GA: Group A, GB: Group B. *p < 0.05.

The data was collected at baseline (day 0), 14^{th} and 21^{st} day (Post intervention). The mean±SD score for MoCA increased from 17.87+2.825 at baseline to 22.60±2.354 on the 14th day and further to 24.47±1.885 on the 21st day. The F-test value of 88.75 and a *p*-value = 3.340 confirm that these changes are statistically significant. The results from the within-group analysis using repeated measures ANOVA indicate a significant improvement in cognitive function in Group A (control group), as measured by the Montreal Cognitive Assessment (MoCA) scales.

Group A (control group) demonstrates a statistically significant improvement in functional status, as assessed by the Modified Barthel Index (MBI). The mean and SD of MBI scores increased from 66.33±6.114 at baseline to 72.00±6.761 on the 14th day and further to 75.67±7.037 on the 21st day. The F-test value of 34.40 and p-value = 3.340 indicate a highly significant improvement, suggesting that functional recovery occurred progressively during the intervention shown in table 2. The Functional Status Improved in Group A, the gradual increase in MBI scores over time highlights the positive impact of intensive cognitive training on activities of daily living (ADLs).

The mean±SD score for MoCA increased from 19.67±3.016 at baseline to 23.40±1.844 on the 14th day and further to 25.87±1.552 on the 21st day. The F-test value of 137.84 and p-value = 3.340 indicate a statistically significant improvement, suggesting that cognitive recovery occurred progressively during the intervention. Group B (experimental group) demonstrates a significant improvement in cognitive function over time, as assessed by the Montreal Cognitive Assessment (MoCA) scales. This provides more evidence that the cognitive scores have significantly improved at each time point.

Group B (experimental group) demonstrates a statistically significant improvement in functional status, as measured by the Modified Barthel Index (MBI). The mean and SD MBI scores increased from 71.33±5.499 at baseline to 79.00±4.309 on the 14th day and further to 82.00±4.551 on the 21st day. The F-test value of 116.71 and a p-value = 3.340 indicate a highly significant improvement, suggesting that functional recovery occurred progressively over the intervention period shown in table 2.

Table 2. The comparison of outcome measures on Baseline, 14th Day and 21th Day in Intra-group for GA and GB

	Group	Baseline (Day "0")	14th Day	21th Day	F-test	T-Value	P-Value
MoCA	GA	17.87±2.825	22.60±2.354	24.47±1.885	88.75	3.340	<0.001
	GB	19.67±3.016	23.40±1.844	25.87±1.552	137.84	3.340	<0.001
MBI	GA	66.33±6.114	72.00±6.761	75.67±7.037	34.40	3.340	<0.001
	GB	71.33±5.499	79.00±4.309	82.00±4.551	116.71	3.340	<0.001

The mean±SD score for MoCA in Group A (Control group) increased from 17.87±2.825 at baseline to 24.47±1.885 at the 21st day, whereas Group B (Experimental group) improved from 19.67±3.016 to 25.87±1.552. While both groups showed cognitive improvements over time, statistically significant difference (p = 0.0346) was achieved only on the 21st day. The unpaired t-test values for the baseline and 14th-day assessments (p = 0.1027 and p = 0.3090, respectively) indicate that initial improvements were not statistically significant shown in table 3a. This suggests that while cognitive training may have an impact, a longer intervention period might be necessary to achieve clinically meaningful changes.

Functional improvement was assessed using the Modified Barthel Index (MBI), which measures independence in activities of daily living. The results of our study indicate a statistically significant improvement in functional status in Group A, with Mean and SD scores increasing from 66.33±6.114 at baseline to 75.67±7.037 at the 21st day as compared to Group B also showed an increase from 71.33±5.499 to 82.00±4.551. The unpaired t-test results revealed statistically significant differences at all time points (p = 0.0258 at baseline, p = 0.0021 at 14th day, and p = 0.0067 at 21st day) shown in table 3b. These findings suggest that intensive cognitive training not only enhances cognitive function but also positively influences functional recovery.

Table 3a. The comparison for Montreal Cognitive Assessment between GA and GB

	Group	Baseline (Day "0")	14thDay	21thDay
MoCA	GA	17.87±2.825	22.60±2.354	24.47±1.885
	GB	19.67±3.016	23.40±1.844	25.87±1.552
Unpaired t-test		1.687	1.036	2.221
P-value		0.1027	0.3090	0.0346
T-value		2.05	2.05	2.05

Table 3b. The comparison for Modified Barthel Index between GA and GB

	Group	Baseline (Day "0")	14thDay	21thDay
MBI	GA	66.33±6.114	72.00±6.761	75.67±7.037
	GB	71.33±5.499	79.00±4.309	82.00±4.551
Unpaired t-test		2.355	3.381	2.927
P-value		0.0258	0.0021	0.0067
T-value		2.05	2.05	2.05

Values represented as Mean±SD; MoCA: Montreal Cognitive Assessment Scale, MBI: Modified Barthel index, GA: Group A, GB: Group B.

4. DISCUSSION

Our results indicate that patients who underwent intensive cognitive training demonstrated improvements in cognitive function, as measured by the Montreal Cognitive Assessment (MoCA) scales. These findings are consistent with previous studies that have highlighted the benefits of early cognitive rehabilitation in stroke patients. A study conducted by Xuefang L at al. (2021)[2] explored the effect of cognitive training and rehabilitation in stroke patients with cognitive dysfunction. Additionally, rehabilitation opens up possibilities for brain relearning. The formation of new connections, dendritic growth, and nerve cell regeneration can all be impacted by appropriate promotion strategies. It's possible that exercise training strengthens the cerebral cortex's capacity for activity, enhances the nervous system's excitability and responsiveness, and encourages the functional reconstruction of damaged brain tissue by increasing the cerebral cortex's thickness and nutrition. After treatment, there was a significant difference between the two groups having the exercise group's score improved significantly. Following therapy, the observation group's improvements in neurological and cognitive function outperformed those of the control group. Their MoCA score was much higher than that of the control group.

Another study conducted by Georgopoulou EN et al. (2023)[16] determined the P-PCT group improved on delayed memory, verbal fluency, attention, processing speed, executive function, general cognitive ability, and activities of daily living, according to evaluations of each group's baseline versus endpoint performance. The C-BCT group, on the other hand, made improvements in processing speed, naming, and memory (both working and delayed). Following the intervention, the comparison between the two groups concluded that the P-PCT group outperformed the C-BCT group on the recall and IADL assessments. When compared to the P-PCT group, the C-BCT group performed much better on the Boston Naming Test, Digit Forward test, and Digital backward test.

A study by Wang Bo et al. (2018)[17] assessed how cognitive function might be affected in stroke survivors with vascular cognitive impairment by a combined intervention of cognitive training and physical activity. Multiple additive mechanisms of cognitive training and physical activity probably contributed to the combined intervention group's larger increase in cognitive performance. Exercise promotes neuroplasticity in specific brain areas and, consequently, cognitive functions. In particular, intense cognitive training caused a reorganization of neural networks and allowed for more effective perceptual and executive processing. Cognitive training and physical exercise may work in tandem to enhance cognitive function. Consequently, cognitive function may be mutually enhanced by cognitive training and physical activity.

There is a lack of studies being conducted to determine the effects of cognitive training on functional status but one observational study conducted by Kil-Byung Lim et al. (2017)[18] investigated the relationship between functional outcome and the Montreal Cognitive Assessment (MoCA) in subacute stroke patients who had cognitive dysfunction. The results of the study concluded that there is a positive correlation between the MoCA score and MBI showing greater the cognitive function, better the functional outcomes or status.

Another longitudinal study conducted by Li J, Wang J et al. (2020)[9] investigated the course of Barthel Index (BI) following a stroke and the relationship between midterm functional results and early cognitive impairment assessed by MoCA in patients with acute ischemic stroke (AIS) in Shanghai. Following a stroke, vascular damage from the stroke and neurodegenerative processes frequently combine to create cognitive impairment. The kind, volume, number, location, and severity of the stroke are linked to the cognitive domains of cognitive impairment. The angular gyrus, the medial frontal lobe, the parietal lobe, the inferomedial part of the temporal lobe, the hippocampus, and the thalamus are all significant strategic sites. Post-stroke cognitive impairment mostly affects frontal brain functions, including working memory, processing speed, reaction time, and executive task assessments. These factors could help to explain why individuals who suffered from dementia or cognitive impairment during the acute phase of a stroke had worse long-term results, including greater levels of disability.

5. CLINICAL IMPLICATION

The study suggested that early and structured cognitive training plays a critical role in improving the cognitive outcomes in patients with post-stroke cognitive impairment. Incorporating such interventions into acute stroke rehabilitation protocols may enhance patient outcomes and functional independence along with reducing the possibilities of any severity.

LIMITATIONS AND FUTURE SCOPE: A limited or small sample size could be viewed as a possible drawback as it can be difficult to generalize study results. The long-term effects of the treatment are unknown as post-study, follow-up, was not conducted. Variables that affect primary and secondary outcome measures, such as the length of complaints, anxiety, and depression, could be further assessed. Changes in lifestyle can be further assessed using outcome measures that center on quality of life.

CONCLUSION: intensive cognitive training combined with functional activities and functional status appears to enhance cognitive function in acute stroke patients with PSCI, with significant effects observed by the 21st day. These findings highlight the importance of structured cognitive rehabilitation in stroke recovery. Our study aligns with existing literature supporting cognitive training as a key component of post-stroke rehabilitation. Future studies should focus on optimizing the duration and intensity of cognitive training interventions to maximize patient outcomes.

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