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EFFECTIVENESS OF CARLO PERFETTI METHOD ON UPPER LIMB MOTOR FUNCTION IN PATIENTS WITH SUBACUTE STROKE

Original Research

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ABSTRACT

Background: Stroke, or cerebrovascular accident (CVA), is a leading global cause of long-term disability and the fourth leading cause of mortality. Impairments following stroke often affect upper limb motor function, impacting daily activities and quality of life. Rehabilitation strategies have evolved to include neurocognitive approaches such as the Carlo Perfetti method, designed to engage both sensory and motor pathways. Evaluating the effectiveness of such interventions in subacute stroke patients is vital for improving functional outcomes.

Objective: To evaluate the effectiveness of the Carlo Perfetti method in improving upper extremity motor function in subacute stroke patients.

Methods: A randomized clinical trial was conducted with 32 subacute stroke patients recruited from Allied Hospital, DHQ Hospital, and Faisal Hospital, Faisalabad. Participants were divided into two equal groups (n=16 each) using purposive sampling. Both groups received baseline Electrical Muscle Stimulation (EMS) three times weekly for 30 minutes over 10 weeks. Group A received additional treatment using the Carlo Perfetti method, while Group B received EMS only. Outcome measures included the Motricity Index, Motor Evaluation Scale for Upper Extremity, and Modified Ashworth Scale, assessed at baseline and at 2-week intervals up to week 10. Statistical analysis was performed using SPSS 20, applying the Friedman test for within-group comparisons.

Results: Group A showed progressive improvement in motor function: Motricity Index mean rank increased from 1.00 at baseline to 6.00 at week 10; Motor Evaluation Scale improved from 1.03 to 6.00. Spasticity reduced significantly, with Modified Ashworth Scale mean rank decreasing from 4.72 to 1.56. All changes were statistically significant (p=0.000). Group B showed moderate improvement with final scores of 3.50, 3.20, and 3.00 respectively.

Conclusion: The Carlo Perfetti method was significantly more effective than EMS alone in improving upper extremity motor function and reducing spasticity in subacute stroke patients.

Keywords: Carlo Perfetti method, cognitive therapy, electrical muscle stimulation, motor function, neurorehabilitation, stroke, upper extremity.

INTRODUCTION

Stroke, derived from the Greek word "apoplexia," has long been recognized as a sudden and often debilitating medical condition that affects millions worldwide. In modern medicine, stroke is defined as a disruption of cerebral blood flow, either due to a blockage or rupture of a blood vessel in the brain, resulting in damage to brain cells and potential long-term neurological impairments (1). These impairments can range from paralysis and sensory loss to difficulties in speech and cognition. Immediate medical intervention is essential to limit neuronal damage, followed by a structured rehabilitation process to maximize functional recovery and quality of life (2). One of the hallmark complications following a stroke, particularly those involving upper motor neuron damage, is spasticity—a velocity-dependent increase in muscle tone during passive movement. This is often accompanied by other forms of muscle overactivity, including hyperreflexia and clonus, contributing to considerable disability and reduced independence (3). Stroke in younger adults, though relatively less common compared to older populations, represents a significant clinical challenge. The prevalence of stroke in individuals below 45 years of age varies globally, accounting for approximately 5% to 20% of all stroke cases. Despite its lower frequency, the consequences in younger individuals are profound, often affecting economically productive years and leading to long-term dependency (4).

Rehabilitation is a cornerstone in stroke management, particularly in the subacute and chronic phases. Various neurorehabilitation techniques have been developed to target post-stroke deficits, including approaches such as Brunnstrom, Bobath, Carr and Shepherd, and Proprioceptive Neuromuscular Facilitation (PNF) (5). These methods emphasize different therapeutic philosophies, from promoting synergistic movement patterns to facilitating functional independence through task-specific training. Cognitive-based therapies are also integrated into rehabilitation to address the emotional and perceptual components of recovery (6). Among these, the Carlo Perfetti method offers a distinct neurocognitive approach that integrates sensorimotor retraining with cognitive engagement. This method is structured in progressive tiers, beginning with exercises aimed at reducing abnormal muscle responses and promoting spatial-temporal control of movement. Patients are often blindfolded during these exercises to enhance proprioceptive awareness, relying solely on kinesthetic and tactile feedback. Therapists provide minimal assistance to avoid reinforcing pathological movement patterns and instead guide patients toward forming perceptual hypotheses, thereby fostering active learning and control (7). A core feature of this method is its emphasis on joint position sense, where patients attempt to identify limb positions or movements without visual cues—an approach grounded in neuroplastic principles (8).

An innovative aspect of the Carlo Perfetti method involves the use of cardboard trajectories for guiding motor tasks. Lines and directional patterns are drawn on cardboard to help patients recognize and replicate movement paths, reinforcing spatial orientation and motor control. This simple, cost-effective tool provides a structured and safe environment for repetitive practice, which is essential for motor learning (9). It also allows for flexibility in therapeutic settings, offering both clinicians and patients a practical means of skill reinforcement (10). These trajectories are designed to improve directionality and enhance motor accuracy, as illustrated in supporting diagrams. Despite its theoretical promise and clinical applicability, the Carlo Perfetti method remains underexplored in scientific literature, particularly in comparison with more established rehabilitation techniques. There is a noticeable gap in empirical evidence regarding its effectiveness in improving motor outcomes in stroke survivors (11). Therefore, this study aims to evaluate the impact of the Carlo Perfetti method on upper extremity motor function in patients recovering from subacute stroke, with the objective of determining its therapeutic value and potential role in contemporary neurorehabilitation strategies.

METHODS

This study employed a randomized clinical trial (RCT) design to evaluate the effectiveness of the Carlo Perfetti rehabilitation method in enhancing upper limb motor function and reducing spasticity among subacute stroke patients. Conducted over a period of four months, the trial adhered to ethical standards following approval from the Board of Advanced Studies and Research (BASAR). Ethical clearance was obtained from the institutional review board, and informed written consent was acquired from all participants prior to their inclusion. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki to ensure participant safety, confidentiality, and autonomy. A total of 32 patients diagnosed with subacute stroke were recruited through consecutive sampling from three tertiary care centers in Faisalabad: Faisal Hospital, Allied Hospital, and District Headquarter (DHQ) Hospital. Participants were randomly assigned into two groups, Group A and Group B, each comprising 16 individuals. Randomization was carried out to ensure balanced distribution of demographic and clinical variables across both groups. Participants were included if they met the following criteria: aged between 40 and 80 years, with a Modified Ashworth Scale (MAS) score of 2, a Mini-Mental State Examination (MMSE) score greater than 24, and a Motricity Index score of less than 99. Patients with prior upper limb musculoskeletal injuries, peripheral nerve lesions, unstable medical conditions, or those already undergoing physiotherapy were excluded from the study.

All participants received a standardized baseline treatment consisting of Electrical Muscle Stimulation (EMS), administered three times per week for 30 minutes per session. EMS parameters were set at a frequency of 20–50 Hz, an amplitude of either 0–100 mA (wide range) or 30–45 mA (narrow range), and a pulse duration of 200–300 µs. This modality aimed to activate muscle fibers and support neuromuscular recovery in both groups. Group A, the intervention group, received additional therapy based on the Carlo Perfetti method, a neurocognitive rehabilitation technique designed to integrate sensory feedback with motor control. In each session, the therapist blindfolded the patient to eliminate visual input and passively moved the affected limb. The patient was then encouraged to identify the movement and joint position, relying solely on proprioceptive feedback. To further engage motor-cognitive pathways, participants practiced tracing specific patterns on paper or cardboard using the affected limb, either actively or passively. These tasks were intended to improve proprioceptive acuity, spatial awareness, and upper limb coordination. Group B, the control group, received only EMS as their sole intervention. Both groups completed their respective treatment protocols over a period of 10 weeks, with therapy sessions scheduled three times per week.

Outcome data were collected at six pre-determined intervals: baseline (week 0), and subsequently at week 2, week 4, week 6, week 8, and week 10. The primary outcome measures used to assess intervention effectiveness included the Motricity Index for evaluating upper limb strength, the Motor Evaluation Scale for Upper Extremity to assess motor function, and the Modified Ashworth Scale for measuring spasticity. All assessments were conducted by evaluators who were blinded to group allocation to minimize measurement bias. Statistical analysis was performed using SPSS version 20. Both descriptive and inferential statistics were applied, with a significance threshold set at $p < 0.05$. The analysis aimed to determine intra-group improvements over time and inter-group differences in response to the intervention. The rigorous study design, including randomization, blinded assessments, standardized outcome measures, and adherence to ethical research protocols, contributed to the reliability and validity of the findings, which provide valuable insights into neurocognitive rehabilitation strategies for subacute stroke recovery.

RESULTS

The study included a total of 32 participants, comprising 17 males (53.13%) and 15 females (46.88%), indicating a slightly higher proportion of male patients. The age of the participants ranged from 43 to 69 years, with the most frequently observed age being 58 years (18.8%). The majority of participants were recruited from Allied Hospital Faisalabad (75%), while 18.75% were from District Headquarter (DHQ) Hospital Faisalabad and 6.25% from Faisal Hospital Faisalabad. In terms of stroke laterality, 62.5% of patients presented with left-sided hemiplegia and 37.5% with right-sided hemiplegia. The normality of the data was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Results from the Shapiro-Wilk test showed a significance value less than 0.05, indicating non-normal distribution of the data; therefore, non-parametric tests were employed for further analysis. Analysis of motor function using the Motricity Index scale revealed a progressive and statistically significant improvement over the 10-week period. The mean rank increased sequentially from 1.00 at baseline to 6.00 by week 10. The Friedman test demonstrated a statistically significant difference across time points (Chi-square = 78.700, p = 0.000). Similarly, the Motor Evaluation Scale for Upper Extremity showed a consistent rise in mean ranks from 1.03 at baseline to 6.00 at week 10. This was also statistically significant (Chi-square = 79.866, p = 0.000), indicating improvement in upper limb motor function. Regarding spasticity, the Modified Ashworth Scale scores showed a steady reduction throughout the intervention period. The mean rank remained at 4.72 during the first two weeks, then decreased progressively to 1.56 by week 10. The Friedman test confirmed a statistically significant decrease in spasticity levels over time (Chi-square = 60.078, p = 0.000), suggesting that the intervention was effective in alleviating muscle tone abnormalities.

Comparative analysis between the intervention group (Group A – Carlo Perfetti method) and the control group (Group B – EMS only) demonstrated significantly superior outcomes in Group A. At week 10, the mean rank scores for the Motricity Index and Motor Evaluation Scale in Group A reached 6.00, compared to 3.50 and 3.20, respectively, in the control group. Additionally, spasticity levels, as assessed by the Modified Ashworth Scale, were markedly lower in the Perfetti group (1.56) compared to the control group (3.00), indicating a greater reduction in hypertonia. Further subgroup analysis based on stroke laterality revealed marginally better outcomes in patients with left-sided hemiplegia, with week 10 mean scores for the Motricity Index and Motor Evaluation Scale at 5.8 and 5.9, respectively, compared to 5.4 and 5.6 in right-sided stroke cases. A similar trend was observed for spasticity reduction, with left-sided cases averaging 1.6 on the Ashworth Scale and right-sided cases at 1.7. The summary of pre- and post-intervention scores confirmed considerable improvement in the Carlo Perfetti group. The Motricity Index increased from 1.00 at baseline to 6.00 at week 10. Similarly, the Motor Evaluation Scale improved from 1.03 to 6.00, while spasticity, as measured by the Modified Ashworth Scale, decreased from 4.72 to 1.56 over the same period. These findings affirm the clinical effectiveness of the Carlo Perfetti method in improving upper limb motor function and reducing spasticity in patients recovering from subacute stroke

Table 1: Demographic Summary

Variable	Value
Total Participants	32
Male	17 (53.13%)
Female	15 (46.88%)
Most Common Age	58 years (18.8%)
Age Range	43-69 years
Left-Sided Stroke	20 (62.5%)
Right-Sided Stroke	12 (37.5%)

Table 2: Group A vs Group B Comparison

Outcome Measure	Group A - Perfetti	Group B - Control	Difference
Motricity Index (Week 10)	6	3.5	2.5
Motor Evaluation Scale (Week 10)	6	3.2	2.8
Modified Ashworth Scale (Week 10)	1.56	3	1.44

Table 3: Subgroup Analysis by Stroke Side

Stroke Side	Mean Motricity Index (Week 10)	Mean Motor Eval Scale (Week 10)	Mean Ashworth Scale (Week 10)
Left-Sided (n=20)	5.8	5.9	1.6
Right-Sided (n=12)	5.4	5.6	1.7

Table 4: Pre- and Post-Intervention Score Summary

Outcome Measure	Pre-Intervention (Week 0)	Post-Intervention (Week 10)
Motricity Index	1	6
Motor Evaluation Scale	1.03	6
Modified Ashworth Scale	4.72	1.56

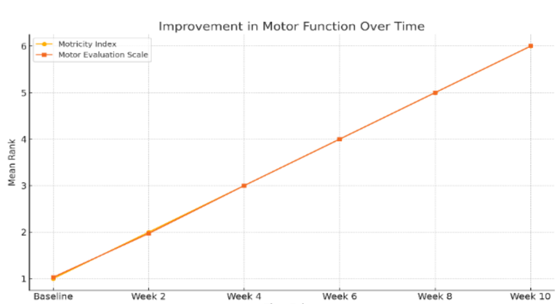

Figure 1 Improvement of Motor Function Over Time

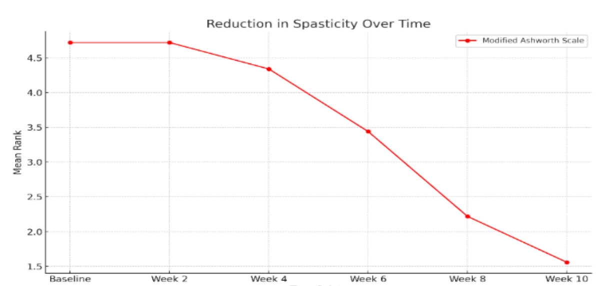

Figure 2 Reduction in Spasticity Over Time

Table 5: Mean Ranks of outcomes

	Mean Rank
Motricity index scale reading at baseline	1.00
Motricity index scale reading at week 2	2.00
Motricity index scale reading at week 4	3.00
Motricity index scale reading at week 6	4.00
Motricity index scale reading at week 8	5.00
Motricity index scale reading at week 10	6.00
Mean Rank of Motor evaluation scale for upper extremity for Carlo Perfetti	
motor evaluation scale for upper extremity reading at baseline	1.03
motor evaluation scale for upper extremity reading at week 2	1.97
motor evaluation scale for upper extremity reading at week 4	3.00
motor evaluation scale for upper extremity reading at week 6	4.00
motor evaluation scale for upper extremity reading at week 8	5.00
motor evaluation scale for upper extremity reading at week 10	6.00
Friedman Test Modified Ashworth scale for Carlo Perfetti	
modified Ashworth scale reading at baseline	4.72
modified Ashworth scale reading at week 2	4.72
modified Ashworth scale reading at week 4	4.34
modified Ashworth scale reading at week 6	3.44
modified Ashworth scale reading at week 8	2.22
modified Ashworth scale reading at week 10	**1.56**

DISCUSSION

The present study adds to the expanding body of literature supporting the use of neurocognitive rehabilitation approaches, particularly the Carlo Perfetti method, in improving motor function and reducing spasticity among subacute stroke patients. The findings demonstrated significant improvements in upper limb function and a marked reduction in muscle tone as assessed by the Motricity Index, the Motor Evaluation Scale for Upper Extremity, and the Modified Ashworth Scale (12). These outcomes suggest that engaging cognitive and sensory pathways through structured motor tasks can enhance neuromuscular recovery and functional independence in this patient population. Comparable results have been reported in previous clinical trials evaluating neurocognitive rehabilitation techniques. One randomized controlled trial highlighted a substantial improvement in upper extremity function following a cognitive sensory motor treatment protocol, aligning with the results observed in the present investigation (13). Additionally, earlier research evaluating the Perfetti method in chronic stroke populations demonstrated notable gains in upper limb control and motor coordination, reinforcing the therapeutic relevance of this intervention in various stages of stroke recovery (14). Further studies have confirmed the superiority of the Carlo Perfetti method over conventional occupational therapy in promoting upper extremity recovery during the acute phase of stroke (15), while evidence from chronic stroke patients has emphasized its utility in enhancing functional capacity and activities of daily living (15,16).

Beyond motor outcomes, research has also pointed to improvements in cognitive function, balance, and muscular strength through cognitive sensory motor interventions, which supports the broader application of the Perfetti approach in comprehensive stroke rehabilitation (17). However, not all findings consistently favor this method. Several investigations have indicated that the effectiveness of the Carlo Perfetti method may vary based on timing, stroke severity, and patient-specific responsiveness. For example, certain trials have found no significant difference between the Perfetti method and traditional therapy approaches, suggesting that its advantages may not be universally superior across all clinical settings (18). These discrepancies highlight the need for individualized rehabilitation strategies and careful selection of therapeutic modalities based on patient profiles. The strengths of the present study include its randomized controlled design, the use of standardized outcome measures, and blinded assessments, all of which contribute to the internal validity of the results. The consistency in treatment protocols and the repeated measurements over a ten-week period offer a reliable

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depiction of the intervention's impact over time. Additionally, the inclusion of a control group receiving baseline treatment allows for a clearer interpretation of the net effect of the Carlo Perfetti method.

Nonetheless, the study is not without limitations. The sample size was relatively small, limiting the generalizability of the findings. The absence of long-term follow-up prevents conclusions about the durability of the treatment effects. Furthermore, while improvements in motor function and spasticity were clearly demonstrated, the study did not assess broader quality-of-life outcomes or the degree of functional independence gained, which are crucial in evaluating the full impact of a rehabilitation intervention. The lack of subgroup analysis by factors such as stroke chronicity, lesion site, or comorbid conditions may have also obscured differential effects within the study population. Future research should prioritize multicenter trials with larger and more diverse samples to validate and expand upon these findings. Investigations examining the integration of the Carlo Perfetti method with other rehabilitation modalities may also reveal synergistic benefits. Moreover, incorporating neuroimaging or neurophysiological measures could provide insights into the mechanisms underlying recovery (19). Longitudinal studies are warranted to determine the sustainability of functional gains and to evaluate the potential role of the Carlo Perfetti method in long-term rehabilitation planning (20). In conclusion, the study supports the clinical utility of the Carlo Perfetti method in subacute stroke rehabilitation, demonstrating its effectiveness in improving upper limb motor function and reducing spasticity. While the evidence is promising, further rigorous investigation is essential to confirm these outcomes and optimize individualized treatment strategies for stroke survivors.

CONCLUSION

The findings of this study conclude that the Carlo Perfetti method is a clinically effective approach for enhancing upper limb motor function and reducing spasticity in patients recovering from subacute stroke. Compared to conservative treatment alone, this neurocognitive rehabilitation technique demonstrated meaningful functional improvements, underscoring its value as a targeted intervention in stroke recovery. The practical implications highlight the method's potential to be integrated into routine rehabilitation programs to support better patient outcomes. Continued research is encouraged to validate these results across broader populations and to explore its effectiveness with other established therapies in long-term rehabilitation settings.

Author Contribution

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Hafsa Naz	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Ayesha Affi	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
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Maria Naeem	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Rozina Naz	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Furqan Ali	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Anbreena Rasool	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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