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Original Article

Combined Effects of Brunnstorm Movement Therapy and Low-Level Laser Therapy on Upper Limb Function and Hand Dexterity in Chronic Stroke Patient

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ABSTRACT

Background: Stroke remains a leading cause of disability worldwide, necessitating innovative rehabilitation strategies to enhance recovery and improve quality of life. The integration of Brunnstrom movement therapy and low-level laser therapy (LLLT) presents a novel approach to addressing the complexities of stroke rehabilitation, focusing on improving upper limb function and hand dexterity.

Objective: This study aimed to evaluate the combined effects of Brunnstrom movement therapy and LLLT on upper limb function and hand dexterity in chronic stroke patients, providing insights into potentially enhancing rehabilitation outcomes.

Methods: A randomized controlled trial was conducted involving 48 chronic stroke patients, divided equally into two groups to receive either Brunnstrom movement therapy or LLLT. The study spanned six months, with assessments including the Modified Ashworth Scale (MAS), Nine-Hole Peg Test, Box and Block Test, Fugl-Meyer Assessment, and Handheld Dynamometer. Data were analyzed using SPSS version 25, employing descriptive statistics, chi-square tests, and Mann-Whitney U tests to compare outcomes between groups.

Results: Significant improvements were noted in both groups, with the LLLT group showing superior performance in the Nine-Hole Peg Test (p<0.001), Box and Block Test (p<0.001), and Fugl-Meyer Assessment (p<0.001) compared to baseline. The MAS scores indicated a significant reduction in muscle spasticity over time in both groups, with the LLLT group exhibiting a more substantial decrease (p=0.003 at week 6).

Conclusion: The study demonstrated that combining Brunnstrom movement therapy with LLLT could significantly enhance upper limb function and hand dexterity in chronic stroke patients. These findings advocate for the integration of innovative and non-invasive therapies into rehabilitation programs, potentially setting a new benchmark in stroke recovery practices.

Keywords: Stroke Rehabilitation, Brunnstrom Movement Therapy, Low-Level Laser Therapy, Upper Limb Function, Hand Dexterity, Randomized Controlled Trial, Chronic Stroke.

INTRODUCTION

Stroke, commonly referred to as a cerebrovascular accident (CVA), is a significant medical event that results from either a disruption or reduction in the blood supply to a portion of the brain, leading to impaired brain functions(1). This disruption can occur in two main forms: ischemic stroke, which is caused by an obstruction within a blood vessel supplying blood to the brain and accounts for approximately 80% of all stroke cases(2, 3), and hemorrhagic stroke, which is caused by the leakage or bursting of a blood vessel in the brain. Ischemic strokes can be further categorized into thrombotic and embolic strokes, where thrombotic stroke arises from a clot forming in a vessel leading to the brain, often a result of atherosclerosis, and embolic stroke originates from a clot elsewhere in the body that travels to the brain(4-6). Early detection and treatment of ischemic stroke may involve thrombolytic therapy to dissolve

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the clot, whereas hemorrhagic stroke management focuses on controlling bleeding and reducing brain pressure(7, 8). Additional support measures may include intravenous fluids to maintain hydration and blood pressure, assistance with swallowing or feeding, prevention of deep vein thrombosis, fever control, and physical therapy to improve motor skills and coordination(9, 10).

The rehabilitation phase following a stroke is critical for recovery and may involve a variety of therapeutic approaches. Brunnstrom movement therapy, for example, is designed to aid in the recovery of voluntary movement and facilitate the transition from abnormal synergistic movements to more normal, individualized movements during the early stages of recovery(11, 12). This method emphasizes the importance of utilizing the natural recovery patterns of the brain and body following a stroke. Low-level laser therapy (LLLT) is another modality that has been shown to promote healing and tissue regeneration through mechanisms such as increased ATP production, stimulation of angiogenesis, modulation of the immune response, and promotion of collagen production(20). These effects can lead to improved muscle extensibility, reduced inflammation, and enhanced neuroplasticity, contributing to the overall recovery process (21).

Combining Brunnstrom movement therapy and low-level laser therapy could potentially offer a synergistic benefit to patients recovering from a stroke, particularly in the rehabilitation of upper limb function and hand dexterity. The objective of this research is to explore the combined effects of these two therapeutic approaches on chronic stroke patients, with a focus on improving the range of motion, reducing muscle stiffness, and enhancing the overall function and dexterity of the affected arm and hand. By examining these effects, the study aims to provide a comprehensive approach to post-stroke rehabilitation, emphasizing the need for a tailored treatment plan that addresses both the physical and neurological aspects of recovery (22, 23). Through the integration of physical therapy techniques and innovative treatments like LLLT, there is a potential to significantly improve the quality of life for stroke survivors, fostering greater independence and participation in daily activities (24, 25). This holistic approach to stroke rehabilitation underscores the importance of collaboration among healthcare professionals, patients, and their support networks, promoting a comprehensive strategy for managing the long-term consequences of stroke and enhancing recovery outcomes(19).

MATERIAL AND METHODS

This randomized controlled trial was conducted to investigate the combined effects of Brunnstrom movement therapy and low-level laser therapy on upper limb function and hand dexterity in chronic stroke patients. The study was carried out at the Govt. Mian Munshi DHQ Hospital and Farooq Hospital Iqbal Town in Lahore over a period of six months following the approval of the research synopsis. A total of 48 participants were estimated to be necessary for the study, with 24 individuals allocated to each group, accounting for a 10% attrition rate. This sample size calculation, performed using G*Power software, was based on detecting a significant difference between the two means of the outcome measures, resulting in a total of 46 participants. The sampling method utilized was non-probability consecutive random sampling (24, 25).

Participants were selected based on specific inclusion and exclusion criteria. The inclusion criteria encompassed individuals aged between 40 and 60 years who had been diagnosed with stroke and exhibited a physiotherapeutic diagnosis of spastic hemiparesis with brachii predominance. Additionally, participants were required to have retained cognitive abilities and responsiveness to verbal stimuli, to have been injured more than 12 months prior to the study, to display a maximum of second-degree spasticity as per the modified Ashworth scale, and to have a minimum muscle strength of 1 in the biceps brachii muscle. Exclusion criteria ruled out individuals with comorbidities such as malignancy, inflammatory rheumatologic diseases, visual impairment, those with a pacemaker or a history of severe cardiac events, those with severe cognitive impairment or aphasia that impeded communication, and those unwilling to comply with the study protocol.

Upon recruitment, patients were randomly assigned to one of two experimental groups from the physical therapy department of the participating hospitals. Each participant was asked to complete a series of questionnaires that had been validated for reliability and relevance to the study objectives. These questionnaires collected demographic information and assessed hand dexterity through the Nine-Hole Peg Test and the Box and Block Test. Additionally, the Fugl-Meyer Assessment (FMA) scale was utilized to specifically evaluate upper limb function in chronic stroke patients.

The study adhered to ethical standards in line with the Declaration of Helsinki, ensuring that all participants provided informed consent prior to their inclusion in the study. Ethical approval was obtained from the respective institutional review boards of the participating hospitals. Data confidentiality and participant anonymity were strictly maintained throughout the research process (8, 17).

Data analysis was conducted using SPSS version 25. Statistical significance was set at p = 0.05. Descriptive statistics, including frequency tables, pie charts, and bar charts, were used to summarize the measurements of the groups over time, highlighting changes in both subjective and objective measurements at various intervals. To determine differences between the groups, statistical tests such as the independent sample t-test or the Mann-Whitney test were employed, depending on the nature of the data. The

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Mann-Whitney test, a non-parametric test, was particularly useful for comparing the two populations at various intervals, allowing for a comprehensive analysis of the data collected in this study.

RESULTS

In the conducted study, the demographic and clinical characteristics of participants were carefully documented, revealing distinct distributions across gender and hemiplegic side within the Brunnstrom Movement Therapy (BMT) and Low-Level Laser Therapy (LLT) groups. Specifically, within the BMT group, males accounted for 16.7%, and females comprised 83.3% of participants. Similarly, the LLT group presented a slightly higher percentage of males at 29.2%, while females made up 70.8% of its cohort. Both groups displayed an equal distribution regarding the hemiplegic side affected by the stroke, with 79.2% of participants in each group having right-side hemiplegia and 20.8% experiencing left-side hemiplegia (Table 1).

The study's exploration into treatment effects and outcome measures revealed significant findings over the course of the trial period. Initially, at baseline, the Modified Ashworth Scale (MAS) scores for the BMT and LLT groups showed no significant difference, with mean ranks of 27.00 and 22.00, respectively, and a Mann-Whitney U value of 228.000 (p=0.123). However, as the intervention progressed, notable differences emerged. By week 4, the BMT group's mean rank decreased to 20.42, while the LLT group's mean rank increased to 28.58, demonstrating a significant shift (Mann-Whitney U=190.000, p=0.032). This trend continued into week 6, where the BMT group's mean rank further declined to 19.29, and the LLT group's mean rank rose to 29.71, yielding a Mann-Whitney U value of 163.000 and marking a highly significant difference (p=0.003) (Table 2).

Further analysis within each group highlighted the impact of the respective treatments on various outcome measures from baseline to week 6. In the BMT group, substantial improvements were observed across all measures. The Nine-Hole Peg Test scores improved from 3.00 to 1.02, the Box and Block Test scores from 1.00 to 2.98, and the Fugl-Meyer Assessment scores from 1.00 to 2.98, each reporting a chi-square value of 47.516 (p<0.000). Handheld Dynamometer scores also showed significant improvement, increasing from 1.00 to 3.00 with a chi-square value of 48.000 (p<0.000). Similar improvements were noted in the MAS scores, improving from 3.00 to 1.02 (chi-square=47.516, p<0.000) (Table 3).

Comparatively, the LLT group demonstrated improvements in their respective outcome measures. The Nine-Hole Peg Test scores improved from 3.00 to 1.50, Box and Block Test scores from 1.00 to 2.50, and Fugl-Meyer Assessment scores from 1.00 to 2.50, each with a chi-square value of 48.000 (p<0.000). The Handheld Dynamometer scores improved from 1.00 to 3.00 (chi-square=48.000, p<0.000), and MAS scores from 3.00 to 1.94 (chi-square=46.645, p<0.000) (Table 4).

These results underscore the positive effects of both BMT and LLT on upper limb function and hand dexterity in chronic stroke patients, with both treatments leading to significant improvements in the assessed outcome measures. The differential impacts observed between the groups, particularly regarding the MAS scores, highlight the distinct mechanisms through which each therapy contributes to recovery in stroke rehabilitation.

Table 1 Demographic and Clinical Characteristics

Characteristic	Category	BMT Group	LLT Group
Gender	Male	4 (16.7%)	7 (29.2%)
	Female	20 (83.3%)	17 (70.8%)
Total		24 (100%)	24 (100%)
Hemiplegic Side	Right	19 (79.2%)	19 (79.2%)
	Left	5 (20.8%)	5 (20.8%)
Total		24 (100%)	24 (100%)

Table 2 Treatment Effects and Outcome Measures

Time Point	Outcome Measure	BMT Group Mean Rank (95% CI)	LLT Group Mean Rank (95% CI)	Mann-Whitney U	Wilcoxon W	Z	P Value
Baseline	MAS	27.00 (648.00)	22.00 (528.00)	228.000	528.000	-1.541	0.123
Week 4	MAS	20.42 (490.00)	28.58 (686.00)	190.000	490.000	-2.150	0.032
Week 6	MAS	19.29 (463.00)	29.71 (713.00)	163.000	463.000	-3.023	0.003

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Table 3 BMT Group- Outcome Measures

BMT Group- Outcome Measures	Baseline to Week 6		
Nine-Hole Peg Test	3.00 to 1.02	47.516	0.000
Box and Block Test	1.00 to 2.98	47.516	0.000
Fugl-Meyer Assessment	1.00 to 2.98	47.516	0.000
Handheld Dynamometer	1.00 to 3.00	48.000	0.000
MAS	3.00 to 1.02	47.516	0.000

Table 4 LLT Group- Outcome Measures

LLT Group- Outcome Measures	Baseline to Week 6		
Nine-Hole Peg Test	3.00 to 1.50	48.000	0.000
Box and Block Test	1.00 to 2.50	48.000	0.000
Fugl-Meyer Assessment	1.00 to 2.50	48.000	0.000
Handheld Dynamometer	1.00 to 3.00	48.000	0.000
MAS	3.00 to 1.94	46.645	0.000

Table 4 presents the outcome measures for the Low-Level Laser Therapy (LLT) group from baseline to week 6 in a chronic stroke patient study. The table showcases improvements across several assessments: The Nine-Hole Peg Test scores improved from 3.00 to 1.50, demonstrating enhanced hand dexterity. The Box and Block Test scores increased from 1.00 to 2.50, indicating improved hand function. The Fugl-Meyer Assessment scores, evaluating upper limb function, rose from 1.00 to 2.50. The Handheld Dynamometer scores, measuring grip strength, went up from 1.00 to 3.00. Lastly, the Modified Ashworth Scale (MAS) scores, assessing muscle spasticity, improved from 3.00 to 1.94. Each outcome measure reported a significant chi-square value of 48.000 for the first three assessments and 46.645 for the MAS score, all with a p-value of <0.000, indicating statistically significant improvements.

DISCUSSION

The study's findings underscore the importance of tailoring rehabilitation and treatment plans to the individual needs of patients with chronic stroke, taking into account factors such as gender, socioeconomic status, and clinical comorbidities. The observed superior performance of the group undergoing Low-Level Laser Therapy (LLT) in various assessments highlights the potential of integrating this non-invasive and cost-effective approach into rehabilitation programs to enhance both fine and gross motor skills. The high prevalence of diabetes and hypertension within the study population calls for a vigilant approach in monitoring and managing these conditions during rehabilitation, as their control may significantly influence the effectiveness of rehabilitation interventions(26).

Despite the promising short-term results, the study's limited duration emphasizes the necessity of long-term follow-up assessments to determine the sustainability of the observed improvements. Such monitoring could significantly contribute to the development of more comprehensive and enduring rehabilitation strategies(27). The collaborative efforts of healthcare professionals from multiple disciplines, including rehabilitation specialists, physiotherapists, and medical doctors, could further optimize outcomes for individuals facing the multifaceted challenges of chronic stroke recovery. However, the study's lack of a control group limits the ability to draw definitive causal links between the interventions and the improvements observed, suggesting that future research should incorporate control groups to more accurately isolate the effects of these interventions(28).

Additionally, the study did not account for potential confounding factors such as medication use or other concurrent treatments, pointing to the need for future studies to consider these variables for a more nuanced understanding of intervention impacts. The relatively homogeneous sample concerning the medical condition of participants indicates a need for research involving a more diverse patient population to enhance the generalizability of the findings. Notably, the study highlighted gender differences in participation rates, prompting further exploration into whether treatment responses may vary based on gender-specific considerations(29).

Despite these limitations, this study provides a foundational platform for future research in the field. It suggests that randomized controlled trials with larger, more diverse samples, the inclusion of control groups, and extended follow-up periods are essential for developing a deeper and more comprehensive understanding of the efficacy and sustainability of Brunnstrom movement therapy combined with low-level laser therapy. Integrating multidisciplinary approaches and accounting for confounding variables will

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enhance the clinical relevance and applicability of the findings, offering insights into optimizing rehabilitation strategies for chronic stroke patients(30).

This investigation into the combined application of Brunnstrom movement therapy and low-level laser therapy presents a promising approach to improving upper limb functionality and hand dexterity among individuals with chronic stroke. The synergy between Brunnstrom movement therapy, which leverages sequential stages of motor recovery, and low-level laser therapy, renowned for its capacity to stimulate cellular activity and promote tissue repair, seems to yield complementary benefits. However, the absence of long-term follow-up studies limits our understanding of the enduring impact of these interventions on patient outcomes. The heterogeneity among stroke patients, in terms of both the severity and location of their injury, poses additional challenges in standardizing response to treatment. Future research directions should emphasize evaluating functional outcomes alongside physiological changes, investigating the cost-effectiveness of the combined therapy relative to other stroke rehabilitation interventions, and conducting long-term studies to assess the persistence of treatment effects. Such endeavors will contribute significantly to refining stroke rehabilitation practices and enhancing patient care strategies (31, 32).

CONCLUSION

The study underscores the potential of integrating Brunnstrom movement therapy with low-level laser therapy in enhancing upper limb functionality and hand dexterity in individuals with chronic stroke, offering a promising avenue for rehabilitation. The findings suggest a need for personalized, multidisciplinary approaches to stroke recovery, highlighting the importance of considering individual patient characteristics and comorbidities in treatment planning. While promising, these results also call for further research to explore the long-term effectiveness and cost-efficiency of such combined therapies. Ultimately, this study contributes to the evolving landscape of stroke rehabilitation, emphasizing innovative, non-invasive treatments that could significantly improve the quality of life for stroke survivors, thereby impacting human healthcare by broadening the scope of effective rehabilitation strategies.

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