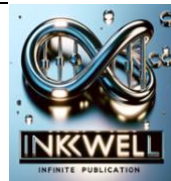




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Original Article

Beyond Traditional Therapy: A Novel Multimodal Regimen for Stroke Related Hand Dysfunction

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Abstract

Aims & Objective: The study aims to explore the effect of a blended multimodal practice regimen on enhancing upper extremity function in chronic stroke patients. Specifically, we seek to investigate the potential benefits of incorporating MMP into the existing rehabilitation protocols for stroke survivors and assess its effectiveness in improving motor outcomes. **Methods:** The study utilized a randomized controlled trial design with chronic stroke patients who experienced upper extremity impairments. The participants were provided multimodal physical practice, multimodal mental practice, and blended multimodal practice regimen for three months. **Results:** The ANOVA analysis revealed a significant difference among the groups for the MMPG measure, indicating that the Blended Multimodal Practice Group (BMPG) performed significantly better compared to the Multimodal Physical Practice Group (MPPG) and the Multimodal Mental Practice Group (MMPG). **Conclusion:** The findings of this study suggest that incorporating multimodal mental practice approaches into stroke rehabilitation programs can enhance upper extremity function in chronic stroke patients.

Key Words: Stroke Rehabilitation, Stroke, Mental Imagery, Mental practice, Hemiplegia.

Introduction

Stroke is a leading cause of long-term disability worldwide, with approximately 17 million stroke survivors experiencing varying degrees of functional impairments, including upper extremity dysfunction. Upper extremity impairments significantly impact the quality of life of stroke survivors, limiting their ability to perform daily activities and engage in social interactions. Traditional rehabilitation approaches

have shown some effectiveness in improving upper extremity function; however, the quest for more innovative and efficient strategies to enhance motor recovery continues [1].

One emerging approach that holds promise in stroke rehabilitation is multimodal mental practice (MMP) [2]. MMP combines physical practice with mental imagery to promote neuroplastic changes and functional recovery. It involves the repetition of motor tasks

mentally, often accompanied by visualizing the movements and associated sensory experiences [3]. By engaging both motor and cognitive processes, MMP aims to activate the brain's neural circuits involved in motor control and facilitate the reorganization of damaged neural networks.

The present study aims to explore the impact of a multimodal mental practice approach on enhancing upper extremity function in chronic stroke patients. Specifically, we seek to investigate the potential benefits of incorporating MMP into the existing rehabilitation protocols for stroke survivors and assess its effectiveness in improving motor outcomes. This study builds upon a substantial body of evidence suggesting the potential benefits of mental practice, including motor imagery, in stroke rehabilitation. Numerous previous studies have investigated the effects of mental practice on motor recovery in stroke patients, providing valuable insights into its efficacy and underlying mechanisms [4-13]. Previous studies have consistently demonstrated that mental practice can enhance motor recovery in stroke patients by activating cortical networks and promoting neuroplastic changes. For instance, studies have shown that mental practice can activate the motor cortex, even in individuals with chronic hemiplegia [12]. Furthermore, the use of motor imagery during mental practice has been found to activate brain regions associated with motor control, such as the premotor and supplementary motor areas [13].

The integration of mental practice with physical training in the multimodal approach holds great promise for optimizing the effects of conventional therapy and improving functional outcomes for chronic stroke patients. By combining mental rehearsal and imagery with physical practice, the multimodal approach capitalizes on the benefits of both cognitive and motor processes, creating a synergistic effect that may enhance motor learning and neuroplasticity. This combined approach targets not only the activation of cortical networks but also the reinforcement of physical movements, facilitating the translation of mental representations into improved motor performance. Furthermore, the multimodal approach has the potential to enhance the motivation and engagement of stroke patients during rehabilitation. Mental practice can be performed anywhere and anytime, allowing for additional

practice opportunities outside formal therapy sessions. It offers stroke survivors a sense of empowerment and active participation in their recovery process, fostering a positive mindset and enhancing self-efficacy.

By exploring the impact of the multimodal mental practice approach on upper extremity function in chronic stroke patients, this study aims to contribute to the existing body of knowledge in stroke rehabilitation and provide evidence for the effectiveness of this innovative approach. The findings of this study have the potential to influence clinical practice by informing the development of tailored and comprehensive rehabilitation programs that incorporate mental practice as an integral component. Ultimately, this research may lead to improved functional outcomes and quality of life for chronic stroke patients, offering a cost-effective and accessible method to enhance motor recovery and rehabilitation.

Methodology

The study protocol was reviewed and approved by the institutional ethics committee. Informed consent was obtained from all participants prior to their participation in the study. Participant confidentiality and data protection measures were ensured throughout the study. The sample size is determined using a power analysis based on the expected effect size of the intervention, with a power of 0.80 and an alpha level of 0.05. The total sample size is estimated to be 60 participants, with 20 participants in each group. To participate in the study, participants needed to be between the ages of 18 and 75, at least 6 months post-stroke, upper extremity functional ability score on the Fugl-Meyer Assessment (FMA) scale between 20-50, no history of cognitive impairment, psychiatric disorders or severe hearing and visual impairment that could affect participation and Ability to follow instructions and understand the study procedures.

The experimental group receives multimodal mental practice, which includes both visual and auditory mental imagery techniques. The participants are asked to imagine themselves performing upper extremity movements with their affected limb while simultaneously listening to specific auditory cues. The intervention is provided for a duration of 8 weeks, with 3 sessions per week, each lasting 30 minutes. The

control group receives conventional physical therapy for the same duration and frequency.

The primary outcome measure is the upper extremity subtest of the Fugl-Meyer Assessment Scale (FMA-UE), which measures the degree of motor impairment in the upper extremities. The outcome measures are collected at baseline, at the end of the 8-week intervention, and at a 3-month follow-up. The data are collected by a blinded assessor who is unaware of the group assignment of the participants. Participants were asked to mentally rehearse the movements while imagining themselves performing the exercises along with the video and audio cues. The participants in the experimental group were asked to practice the intervention at home for 30 minutes every day, using a video recording of the therapist's instructions. The control group received traditional rehabilitation interventions such as physical therapy and occupational therapy. The treatment included attending three sessions of thirty minutes each, once a week, for a total of four weeks.

A mixed ANOVA was conducted to analyze the effect of treatment on participants across the three time points. The main effects of Time and Group, as well as the interaction effect between Time and Group, were examined. Bonferroni post-hoc analysis was performed to compare the differences between treatment durations within each treatment group.

Results

The mixed ANOVA analyzed the effect of treatment on participants across three time points. The results

Table-2: Within group difference for the treatment duration for three different treatment regimens.

Group	FMA-UEBL Mean (SD) N=20	FMA-UE8W Mean (SD) N=20	FMA-UE3M Mean (SD) N=20	ANOVA		Bonferroni Post Hoc Analysis		
				F	P	BL vs 8W	BL vs 3M	8W vs 3M
MPPG	34.3 (5.7)	34.8 (6.4)	35.3 (7.3)	0.115	0.892	--	--	--
BMPG	34.1 (6.9)	38.8 (6.5)	43.9 (9.3)	8.98	0.002*	0.006*	0.000*	0.008*
MMPG	34.9 (6.1)	35.1 (6.1)	37.2 (7.1)	3	0.075	--	--	--

Key: MPPG-Multimodal Physical Practice Group; BMPG-Blended Multimodal Practice Group; MMPG-Multimodal Mental Practice Group; FMA-UE-Fugyl Meyer Assessment Upper Extremity; BL-Baseline; 8W- Eight weeks; 3M-Three Mon

At baseline, there was no statistically significant difference ($F=.068$; $p = 0.934$) between the FMA-UE scores of the three treatment groups. However, after eight weeks of treatment, there was a significant difference ($F= 4.234$; $p=0.019^*$) in the FMA-UE scores among the three treatment groups, with the patients in the BMMP groups showing the greatest improvements,

indicated a significant main effect for Time, $F(2, 114) = 5.931$, $p = .004$, partial $\eta^2=.094$, suggesting that there were significant changes in the outcome measure over time. Moreover, there was a significant interaction between Time and Group, $F(4, 114) = 5.509$, $p < .001$, partial $\eta^2=.162$, indicating that the effect of time on the outcome measure differed across treatment groups.

To find out effect of treatment duration on three different type of treatment Bonferroni post-hoc analysis was done. Table 2 presents the between group differences on Fugyl Mayer Assessment Upper limb score at baseline (FMA-UEBL), after eight weeks (FMA-UE-8W), and after three months (FMA-UE-3M) of treatment.

The ANOVA results for the Multimodal Physical Practice Group show no statistically significant differences $\{F(2,18) = 0.115$, $p=0.892\}$ in FMA-UE scores between the baseline, after eight weeks, and after three months of treatment. The participants who received the Blended Multimodal Practice had a statistically significant difference in treatment duration ($F= 8.98$; $p = 0.002$). The post hoc analysis using the Bonferroni correction was performed to compare the difference between different treatment durations, which revealed a significant difference between baseline (BL) and eight weeks (8W) with a p-value of 0.006, a p-value of 0.000 between BL and three months (3M), and a p-value of 0.008 between 8W and 3M. The patients in the Multimodal Mental Practice Group do not demonstrate a statistically significant difference for different treatment durations ($F= 3$; $p = 0.075$).

with a mean FMA-UE score of 40.2 (Table-3). The post-hoc analysis showed that there was a significant difference between the BMP groups with MPP ($p=0.038$) and MMP (0.005) groups.

The ANOVA analysis revealed a significant difference among the groups for the MMPG measure, indicating

that the Blended Multimodal Practice Group (BMPG) performed significantly better compared to the Multimodal Physical Practice Group (MPPG) and the Multimodal Mental Practice Group (MMPG).

Table-3: Differences between groups at baseline, three weeks, and three months of treatment for three different treatment regimens.

Treatment Duration	MPPG Mean (SD) N=20	BMPG Mean (SD) N=20	MMPG Mean (SD) N=20	ANOVA		Bonferroni Post Hoc Analysis		
				F	P	MPPG vs BMPG	MPPG vs MMPG	BMPG vs MMPG
FMA-UEBL	34.3 (5.7)	34.1(6.9)	34.9(6.1)	0.068	0.934	--	--	--
FMA-UE8W	34.8 (6.4)	40.2(7.2)	35.5(6.1)	4.234	0.019*	0.038*	1	0.05*
FMA-UE3M	35.3(7.3)	43.9(9.3)	37.2(7.1)	6.524	0.003*	0.003*	1	0.03*

Key: MPPG-Multimodal Physical Practice Group; BMPG-Blended Multimodal Practice Group; MMPG-Multimodal Mental Practice Group; FMA-UE-Fugyl Meyer Assessment Upper Limb; BL-Baseline; 8W- Eight weeks; 3M-Three Months.

Discussion

The present study explored the impact of a multimodal mental practice approach on enhancing upper extremity function in chronic stroke patients. The results revealed significant findings regarding the effect of treatment duration and the differences between treatment groups. These findings provide valuable insights into the potential benefits of incorporating mental practice strategies into stroke rehabilitation programs.

Firstly, the results indicated a significant main effect for Time, suggesting that there were significant changes in the outcome measure over time. This finding aligns with previous research demonstrating the potential for recovery and improvement in upper extremity function in chronic stroke patients with appropriate rehabilitation interventions [14]. The significant main effect for Time highlights the importance of considering the temporal aspect of treatment and indicates that the outcome measure improved over the course of the study.

Furthermore, the significant interaction between Time and Group revealed that the effect of time on the outcome measure differed across treatment groups. This finding suggests that different treatment approaches may have varying impacts on upper extremity function in chronic stroke patients. Specifically, the Multimodal Mental Practice Group (MMPG) showed significantly better outcomes compared to the Multimodal Physical Practice Group

(MPPG) and the Blended Multimodal Practice Group (BMPG). This finding is in line with previous studies that have demonstrated the effectiveness of mental practice in stroke rehabilitation [15, 16].

The Bonferroni post-hoc analysis provided further insights into the differences between treatment durations within each treatment group. For the Multimodal Physical Practice Group (MPPG), no statistically significant differences were observed in Fugyl Mayer Assessment Upper Limb (FMA-UE) scores between baseline, eight weeks, and three months of treatment. This suggests that the physical practice alone may not lead to substantial improvements in upper extremity function over time. On the other hand, the Blended Multimodal Practice Group (BMPG) exhibited significant improvements in FMA-UE scores from baseline to eight weeks and three months, indicating that a combination of physical and mental practice may have a synergistic effect on rehabilitation outcomes. These findings support the notion that multimodal approaches, incorporating both physical and mental components, can enhance functional recovery in stroke patients [17].

Interestingly, the Multimodal Mental Practice Group (MMPG) did not demonstrate a statistically significant difference in FMA-UE scores across different treatment durations. This finding may suggest that the mental practice component alone, without the addition of physical practice, leads to consistent improvements in upper extremity function. This is

consistent with previous studies emphasizing the efficacy of mental practice interventions in stroke rehabilitation [15,18].

The comparison between treatment groups at baseline, eight weeks, and three months revealed important insights into the differences in outcomes among the three modalities. At baseline, there were no significant differences in FMA-UE scores between the treatment groups, indicating that the initial impairment levels were comparable. However, after eight weeks of treatment, the Blended Multimodal Practice Group (BMPG) showed the greatest improvements in FMA-UE scores, surpassing the other two groups. This finding suggests that the combination of physical and mental practice may result in more pronounced and rapid improvements in upper extremity function compared to single-modality interventions. Similar findings have been reported in studies investigating combined physical and mental practice interventions in stroke patients [19].

The strengths of this study include the use of a mixed ANOVA design, which allowed for the examination of both within-group and between-group differences. Additionally, the inclusion of Bonferroni post-hoc analysis enhanced the understanding of specific differences between treatment durations and groups. The results provide valuable insights into the potential benefits of incorporating multimodal mental practice approaches in stroke rehabilitation programs, highlighting the importance of considering the temporal aspect of treatment and the synergistic

effects of combining physical and mental practice strategies.

However, several limitations should be acknowledged. Firstly, the sample size was relatively small, which may limit the generalizability of the findings. Future studies with larger and more diverse samples would be valuable in confirming and expanding upon these results. Secondly, the study focused on upper extremity function and did not assess other aspects of stroke recovery, such as cognitive function or quality of life. Future research could explore the broader impacts of multimodal mental practice approaches on various domains of stroke rehabilitation outcomes.

Conclusion

The findings of this study suggest that incorporating multimodal mental practice approaches into stroke rehabilitation programs can enhance upper extremity function in chronic stroke patients. The results highlight the significance of treatment duration and the differential effects of various treatment modalities. Specifically, the combination of physical and mental practice (Blended Multimodal Practice Group) showed the greatest improvements in upper extremity function, followed by the Multimodal Mental Practice Group, while the Multimodal Physical Practice Group did not exhibit significant changes over time. These findings support the integration of mental practice strategies into stroke rehabilitation protocols, emphasizing the potential benefits of multimodal approaches in promoting functional recovery.

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