

Customized Mirror Therapy with Object on Paretic Hand for Handgrip and Gross Motor Hand Functions in Patients with Middle Cerebral Artery Stroke: A Pretest-Posttest Quasi Experimental Study

Jatin Sangwan*, Asir John Samuel, Urvashi, and Vencita Priyanka Arahna

Department of Pediatric and Neonatal Physiotherapy, University of Maharishi Markandeshwar, Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Mullana, India

*Corresponding author: Jatin Sangwan, Department of Pediatric and Neonatal Physiotherapy, University of Maharishi Markandeshwar, Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Mullana, India, E-mail: sangwanjatin123@gmail.com

Received date: November 25, 2022, Manuscript No. IPSRT-22-14598; Editor assigned date: November 28, 2022, PreQC No. IPSRT-22-14598 (PQ); Reviewed date: December 08, 2022, QC No. IPSRT-22-14598; Revised date: December 15, 2022, Manuscript No. IPSRT-22-14598 (R); Published date: December 26, 2022, DOI: 10.36648/IPSRT.22.06.151

Citation: Sangwan J, Samuel AJ, Urvashi, Arahna VP (2022) Customized Mirror Therapy with Object on Paretic Hand for Handgrip and Gross Motor Hand Functions in Patients with Middle Cerebral Artery Stroke: A Pretest-Posttest Quasi Experimental Study Stroke Res Ther Vol.6 No.5:151.

Abstract

Background: Quality of life is affected in patients of MCA stroke due to continuous motor limitations of hand. We have developed customized mirror therapy with object on paretic hand to promote hand function and grip in patients with MCA stroke.

Purpose: To analyze the effectiveness of CMT with object on paretic hand in improving gross motor hand function and handgrip strength in patients with MCA stroke.

Method: Six patients with hemiparesis after MCA stroke were included in this pretest-posttest quasi experimental. Standardized hand exercises were performed in a customized mirror box with bilateral hands for 20 intervention sessions in addition to regular physiotherapy. All participants were assessed for Michigan hand outcome questionnaire, handgrip strength with sphygmomanometer and Brunnstrom grades of hand recovery stages at baseline, 2nd week and 4th week of intervention.

Result: Age, height, weight and BMI of six P-MCA stroke recruited were, 64.5 (48.5-70.9) years, 159.9 (153.1-167.9) cm, 56.8 (50.4-63.9) Kg, and 22.3 (18.6-26.1) Kg/m² respectively. Significant changes were noted when measured at 2nd and 4th week in Michigan hand outcome questionnaire ($p=0.011$), handgrip strength ($p=0.017$) and, Brunnstrom hand recovery stages ($p=0.007$).

Conclusion: Customized mirror therapy with object on paretic hand might be a feasible intervention in improving gross motor hand functions and handgrip strength of P-MCA stroke.

Keywords: Infarction; Middle cerebral artery; Upper extremity; Hand strength

to perform activities of daily life and these are affected by continuous motor limitation of hand in stroke. Dexterity skills mean the potential of a person to grasp and manipulate things by precise hand and finger movement. Manipulation of an object is influenced by weakness of wrist extensors, finger and thumb flexors, extensors, adductors and abductors. Overall, health status of elderly individuals are represented by their handgrip strength. Patients with stroke have difficulty in holding and controlling grip force during grabbing and lifting the object. This affects the Activities of Daily Living (ADL) to the greater extend [1].

Recent study on mirror therapy supports improvement in Brunnstrom stages and functional activities of hand in patients with stroke. Exercise performing in front of mirror box excite the mirror neuron system which contains visuomotor neuron. Mirror therapy helps in regaining motor functions, ADL, sensation loss, phantom pain, visuospatial neglect, etc. The basic principle of mirror therapy is that non-hemiparetic limb image is used to regain motor activities and remove burning, prickling, tingling sensations. Visual feedback helps in inducing neuroplasticity to produce recovery due to stimulation of the cerebral hemisphere [2].

The present study was aimed to determine the effect of CMT with object on paretic hand in improving handgrip strength and hand functions in patients with stroke. The traditional mirror box consisted of triangular in shape structure which is made up of plywood. 2D mirror frame is placed between the two arms and inclined in such a way that patient was able to view the reflection of normal hand in the mirror without viewing the affected arm. When the unaffected limb is moved, the mirror image tricks the brain into thinking that affected limb is moved. The illusion causes changes in the brain due to mirror neuron activation that helps the person to improve their hand mobility when the attempted movement in affected hand [3]. Whether CMT with object on paretic hand helps to improve handgrip and hand functions in patients with MCA stroke is the research question. Hence, the objective of the study is to estimate the effect of CMT with object on paretic hand in improving handgrip strength and hand functions in P-MCA stroke after four weeks of intervention [4].

Introduction

Stroke is the second reason for increasing death rate and third reason for increasing disability rate. Dexterity skills are required

Methods and Materials

Ethics

This study was approved by the Institutional Ethical Committee of MMIMS and R, Mullana, Ambala and Haryana on 22nd Jan, 2021. All study procedures were performed according to the Helsinki Declaration revised in 2013 and the national ethical guidelines for biomedical research involving human participants 2017. The voluntary signed informed consent related to study participation were taken from all the subjects after explaining about the pros and cons of present study [5,6].

Study design

A single group pretest-posttest quasi experimental study. The study took place in a community setup at the home or garden of patients with MCA stroke. Selected participants received CMT with objects on paretic hand for hand functions [7].

Participants

Six P-MCA stroke were recruited from the community in around the tertiary care teaching rehabilitation center. The hand rehabilitation protocol is designed to improve handgrip strength, hand function and quality of life of stroke patients. The inclusion criteria for this study were, patients with MCA stroke with duration <1 year, both male and female in the age group 50–80 years. The patients, who had history of seizures, impaired sitting balance, shoulder subluxation, severe hand deformities, vision impairment and cerebellar symptoms were excluded from their participation in the study [8].

Procedure

Anthropometrics measurements were taken before the start of study. Detailed study procedure was explained to the P-MCA

stroke recruited related to standardized set of exercise protocol developed to be used with CMT with objects on paretic hands. Each P-MCA stroke underwent a standardized exercise protocol for CMT with object on paretic hand consisting of 20 sessions, 30 min/day, and 5 days/week for 4 weeks. Pre-assessment and post-assessment such as, handgrip strength by a sphygmomanometer, quality of life by Michigan hand outcome questionnaire and hand functions by Brunnstrom hand recovery stages were recorded to demonstrate the changes post intervention [9,10].

Intervention

The intervention protocol consisted list of standardized exercises performed in CMT with object on paretic hand in front of the mirror box. The objects of the same size and shape were given to the participants in both hands. The aim of using the object is to improved handgrip strength and hand functions were listed in (Table1). The P-MCA stroke was made to sit on a chair without a backrest while focusing at the mirror and hemiparetic hand was placed inside the mirror box [11]. A mirror box was placed between the extremities and vertically to a table (Figure 1) in front of them so that image of a non-hemiparetic hand gets reflected in the mirror. P-MCA stroke could see only a non- hemiparetic hand in the mirror and instructed to hold the object which was placed inside the mirror box in contact with hemiparetic hand and similar objects were placed outside the mirror box in contact with a non-paretic hand. Mirror image stimulates the brain and visual illusion from mirror box stimulates movement of the affected hand. When P-MCA stroke try to grasp the object with palm of both paretic and non-paretic hand, it stimulates the tactile sensation of hand, improve sensory dysfunction, hand function and handgrip strength. Each exercise was performed for 12 repetitions×3 sets/ session for 5 days in a week for 4 weeks (Table 1) (Figure1).

Sr. No	Exercises	Purpose
1	Holding and releasing of ball	Spherical grip
2	Holding and releasing of can	Spherical grip
3	Holding and releasing of credit card	Spherical grip
4	Holding and releasing of key	Spherical grip
5	Holding and releasing of door handle	Spherical grip
6	Flexion and extension of hand	Spherical grip
7	Supination and pronation	Spherical grip
8	Opening and closing of fist	Spherical grip
9	Touch fingers with thumb	Spherical grip

Table 1: Standardized exercises for customized mirror therapy with objects on paretic hand.



Figure 1: Customized mirror box placement.

Outcome Measures

Handgrip strength test

Handgrip strength was measured by using a sphygmomanometer. The patient was made to be in high sitting position with the arm adduction, elbow flexed 90°, forearm and wrist in a neutral position. The initial range in the sphygmomanometer is set at 40 mmHg and when the patient squeezes the cuff the examiner carefully recorded the final range. The initial range is subtracted from the final range to get the change score as a measure of handgrip strength. The measurements were performed 3 times and values were averaged. Overall readings were recorded at baseline, 2nd week and 4th week of intervention [12].

Hand function recovery

Hand function in P-MCA stroke were graded in accordance with the standard recommendation described by Signe Brunnstrom and colleagues in their book regarding the six motor recovery stages of hemiplegic hands. Higher Brunnstrom grades indicate improvement in the hand function of a patient. Hand function recovery stages according to Brunnstrom were recorded at baseline, 2nd week and 4th week of intervention [13].

Quality of life

Michigan Hand Questionnaire (MHQ) contains six scales used to rate the quality of life in patients with hand dysfunction. A higher score on the pain scale indicates more pain and a higher score on the other 5 scales indicates better performance. The final score was calculated by adding 6 subgroup findings and divide by six. The score is normalizing on a scale from 0-100 where a lower score indicates the severity of the disability. 15 MHQ was recorded at baseline, 2nd week and 4th week of intervention.

Timeline

All the above outcome measures were recorded at baseline, end of 2nd and 4th week of intervention.

Statistical Analysis

All the data collected were subjected to normality test, Shapiro-Wilk test. As the data does not follow the normal distribution, the central tendency and dispersion were reported in geometric mean with 95% Confidence Interval (CI) for the demographic parameters and median with Interquartile Range (IQR) for handgrip strength, Brunnstrom hand recovery stages and Michigan hand questionnaire. Friedman test was used to determine the significant difference of the above outcome measured at baseline, end of 2nd and 4th week of intervention. For all the above analysis, the level of significance was set at $p < 0.05$. Statistical Package for the Social Sciences (SPSS) version 20.0 was used to assist in data analysis [14,15].

Result

Six P-MCA stroke were participated in the study with 100% compliance. The demographic parameters of the recruited P-MCA stroke were tabulated in Table 2. In Table 3 the outcome measures, handgrip strength, Brunnstrom hand recovery stages and Michigan hand questionnaire were expressed in median with IQR. There exists significant difference ($p < 0.001$) in all the outcome measures measured at baseline, end of 2nd and 4th week of intervention. Box and Whisker plot which report median with IQR and range was used to display the changes in the outcome measures, handgrip strength (Figure 2), Brunnstrom hand recovery stages (Figure 3) and Michigan hand questionnaire (Figure 4) measured at baseline, end of 2nd and 4th week of intervention.

Demographic characteristic	Geometric mean (95% CI)
Age (years)	64.5 (48.5-70.9)
Height (cm)	159.9 (153.1-167.9)

Weight (Kg)	56.8 (50.4-63.9)
BMI (Kg/m ²)	22.3 (18.6-26.1)
MMSE	26.83 ± 2.13

Table 2: Demographic characteristics of the participants.

Variables	Baseline	Post-intervention 1	Post-intervention 2	P-value
MHQ	26.16 (15.55-42.55)	38.16 (16.41-45.89)	43.66 (17.72-52.38)	0.01
HGS	15 (0.00-30.00)	22.5 (0.00-40.00)	30 (0.00-70.00)	0.01
BRS-H	3.5 (1.00-5.00)	4 (1.00-6.00)	50 (4.00-6.00)	0.04

Table 3: Michigan hand outcome questionnaire, hand grip strength and brunnstrom recovery stages of hand measured at baseline, 2nd week post-intervention and 4th week post-intervention.

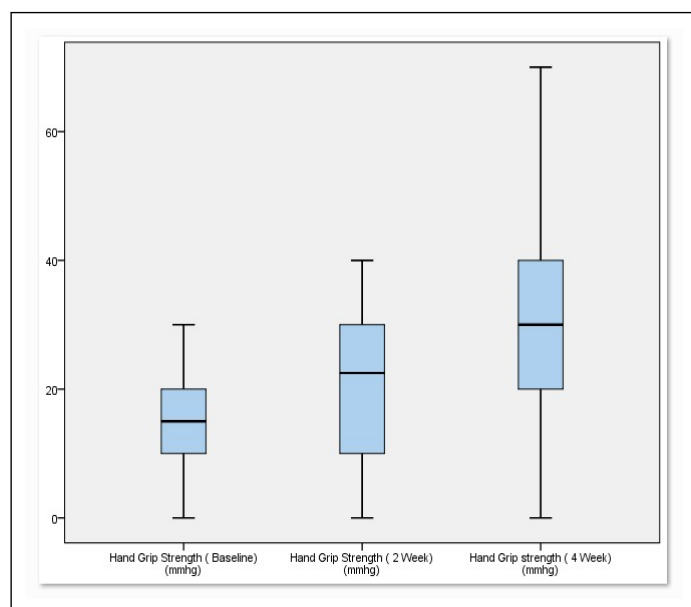


Figure 2: Handgrip strength measured by sphygmomanometer at baseline, 2nd week and 4th week of intervention.

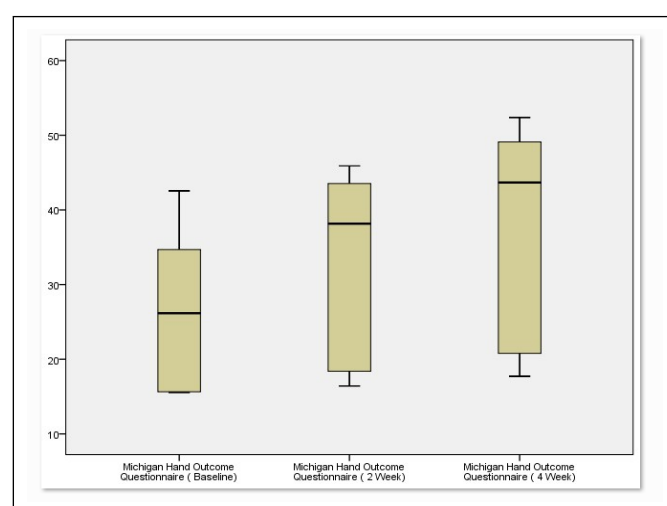


Figure 4: Hand outcome in P-MCA stroke measured by Michigan hand outcome questionnaire assessment at baseline, 2nd week and 4th week of intervention.

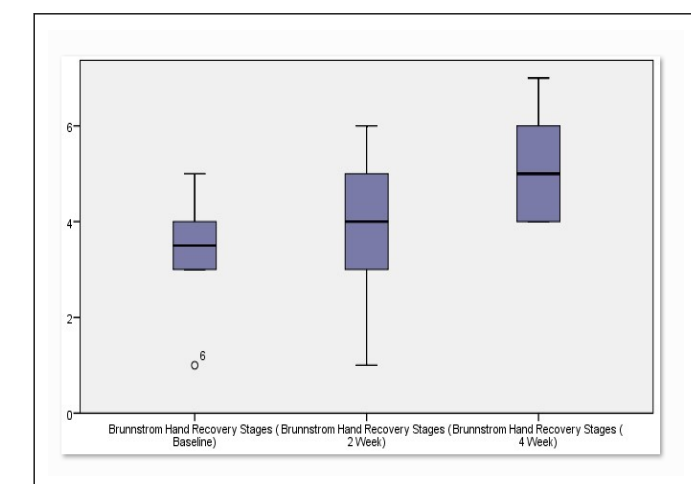


Figure 3: Hand recovery recorded by Brunnstrom hand recovery stages assessed at baseline, 2nd week and 4th week of intervention.

Discussion

Based on the above results, we confirm that CMT with objects on paretic hand might have positive effect in improving handgrip strength, hand function, and quality of life in P-MCA stroke after four weeks of intervention. Thus, this was in line with our objective and thereby verifies our objective. When compared with the previous research, NigarGurbuz MD used a traditional mirror therapy program 60-120 min/day, 5 days/week for four weeks in the randomized controlled trial study on stroke patients. The pre and post-assessment changes in BRS-H were found high in the mirror group ($p=0.001$) as compared to the conventional group ($p=0.006$). The results of this study show significant improvement in BRS-H ($p=0.04$) and similar to them.

Changes in grip strength and outcomes related to hand function *i.e.* box and block test show a statistically significant difference between two groups ($p<0.05$). As shown in the previous study, there was no significant changes found in handgrip strength in chronic stroke patients ($p=0.09$). This may be due to the facilitation of wrist and finger extensors by stimulation. Electrical stimulation facilitate hand opening and

never facilitate the closing of a fist. The present results show significant improvement in grip strength from pre to post-assessment ($p < 0.05$). This improvement may be possible due to the facilitation of wrist and finger flexors by grasping different objects. The study done by Henk Arwert in 2017 in which patients with stroke reported about hand functions after 3 years of stroke. 207 patients participated in cross sectional survey study shows median value 79.9.15 The results of present study shows that change in pre to post median values of MHQ is 26.16 to 43.66 ($p = 0.01$). We have obtained increasing trend in MHQ following four weeks of CMT with objects on paretic hand. As in the previous research, they have recruited patient with chronic stroke against sub-acute in the study, the difference might be clinically acceptable.

The traditional mirror box is a triangular-shaped structure that is made up of plywood. The patient holds the object with a non-paretic hand and the paretic hand is placed in a mirror box without holding any object. But in this study patients also try to hold the object with a paretic hand. Pairs of objects similar in shape, size and weight are used. CMT with object on paretic hand is a low-cost rehabilitation method for patients and staff, easy to use and integrated into the home environment. The material which is used can be easily available in the market and can be made in different sizes according to the patient. The benefit of CMT with object on paretic hand is when the patient has mastered then they can perform exercise of hand alone at home and it is a safe treatment intervention that can be performed in the room while sitting on the chair. The exercise protocol adopts according to the rural area. Same time was not maintained for all patients because it is door to door approach and by which attains 100% adherence of the participants were maintained. It can encourage voluntary participation of the subject by inducing interest in performing exercises in the mirror box. CMT with objects on paretic hand seems to improve motor functions of the hand by activation of the brain primary cortex and visuomotor areas of the brain.

Convenience sampling method is used for the recruitment of participants. Because limited samples are available for the study due to COVID 19 restrictions, we have limited time and fewer interactions with the patient. Generalization of this result to wider population might not be feasible at present. Overall, the main limitations of this research is limited time period, small sample size, only MCA stroke patients selected, a single group is taken for study, and chronic stroke patients not included. Accordingly, future research can be done with larger sample size and there should be homogenous samples taken for the study, could be focused on younger stroke patients and chronic stroke patients. However, this study provides an insight to novel CMT with object on paretic hand in improving gross motor hand function and handgrip strength in P-MCA stroke. Hence, extrapolation of these results to wider population should be done with caution.

The 4 weeks intervention of CMT with object on paretic hand confirmed the positive effect of hand functions, Handgrip strength and quality of life of the patient with acute stroke.

Conclusion

CMT with objects on paretic hand might have a positive effect on improving gross motor hand function and handgrip strength of a patient with acute MCA stroke. Further studies are needed to substantiate these effects on wider population with narrow confidence interval randomized controlled trial.

Acknowledgement

The author would like to thank the Deanship of Scientific Research at Majmaah University, Al Majmaah, 11952, Saudi Arabia for supporting this work.

Conflict of Interest

None

Ethical Statement

The study was performed according to the principles laid by, declaration of Helsinki (Revised 2013), Council for International Organizations of Medical Sciences (CIOMS) guidelines, International ethical guidelines for health-related research involving humans (2016) and National guidelines for biomedical and health research involving human participants (2017).

Informed Consent

The voluntarily consent was taken from all the subjects in Hindi and English language after explaining about the pros and cons of present study.

References

1. Camona C, Wilkins KB, Drogos J, Sullivan JE, Dewald JPA, et al. (2018) Improving hand function of severely impaired chronic hemiparetic stroke individuals using task-specific training with the rein-hand system: A case series. *Front Neurol* 9:923
2. Yun GJ, Chun MH, Park JY, Kim BR (2011) The synergic effects of mirror therapy and neuromuscular electrical stimulation for hand function in stroke patients. *Ann Rehabil Med* 3: 316.
3. Wolbrecht ET, Rowe JB, Chan V, Ingemanson ML, Cramer SC (2018) Finger strength, individuation, and their interaction: Relationship to hand function and corticospinal tract injury after stroke. *Clin Neuro Physiol* 129: 797-808.
4. Israely S, Leisman G, Carmeli E (2017) Improvement in arm and hand function after a stroke with task-oriented training. *BMJ Case Rep* 10: 1136-1143.
5. Martin GM (1965) Stroke rehabilitation. *S D J Med* 18: 20-26.
6. Kim J, Yim J (2017) Effects of an exercise protocol for improving handgrip strength and walking speed on cognitive function in patients with chronic stroke. *Med Sci Monit* 23: 5402-5409.
7. Yeldan I, Huseyinsinoglu BE, Akinci B, Tarakci E, Baybas S (2015) The effects of very early mirror therapy on functional improvement of the upper extremity in acute stroke patients. *J Phys Ther Sci* 27: 3519-3524.

8. Luo Z, Zhou Y, He H, Lin S, Zhu R, et al. (2020) Synergistic effect of combined mirror therapy on upper extremity in patients with stroke: A systematic review and meta-analysis. *Front Neurol* 11.
9. Gurbuz N, Afsar SI, Ayaş S, Nur S, Cosar S (2016) Effect of mirror therapy on upper extremity motor function in stroke patients: A randomized controlled trial. *J Phys Ther Sci* 28: 2501-2506
10. Tosi G, Romano D, Maravita A (2018) Mirror box training in hemiplegic stroke patients affects body representation. *Front Hum Neurosci*.
11. Muthuswamy V (2014) The new 2013 seventh version of the declaration of helsinki—more old wine in a new bottle ?
12. Mathur R, Swaminathan S (2017) National ethical guidelines for biomedical and health research involving human participants: A commentary. 3: 201-204.
13. Martins JC, Aguiar LT, Lara EM (2015) Assessment of grip strength with the modified sphygmomanometer test : Association between upper limb global strength and motor function. 19: 498-506.
14. Arwert H, Schut S, Boiten J, Vlieland TV, Meesters J (2018) Patient reported outcomes of hand function three years after stroke. *Top Stroke Rehabil* 25: 13-19.
15. Higgins J, Koski L, Xie H (2013) Combining rTMS and task-oriented training in the rehabilitation of the arm after stroke: A pilot randomized controlled trial. *Stroke Res Treat*.