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A STUDY TO FIND OUT THE EFFICACY OF REHABRELIVE ACTIVE GLOVE TO IMPROVE HAND FUNCTION IN STROKE PATIENTS

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ABSTRACT

Reducing upper-extremity impairment in stroke survivors is still challenging despite many conventional approaches. Therefore, innovative rehabilitation programs are preferred. This study aims to check the effect of RehabRelive Active glove therapy in improving hand function in stroke survivors. A prospective, interventional study was conducted in patients with subacute and chronic stroke patients. 24 participants were allocated to the experimental group or the control group. The experiment group underwent 45 minutes of conventional physical therapy plus 15 minutes of glove therapy, and 5 minutes of conventional hand treatment. The control group underwent 45 minutes of conventional physical therapy plus 20 minutes of conventional hand therapy. All participants underwent each intervention 4 days/week for four weeks. They were evaluated before and 4 weeks after the intervention. The primary outcome measure was the change in the score of the Fugl-Meyer Assessment of Upper Extremity (wrist and hand component) and the secondary outcome measures were the box and block test, and Chedoke arm and hand activity inventory. Independent t-test or Mann-Whitney U test was applied to compare the outcome measures of both groups. Results of this study showed that RehabRelive glove therapy showed improvement in all outcome measures, which confirms the efficacy of glove therapy. However, there is no statistically significant difference found in comparison of the intervention group with the control group. RehabRelive active glove therapy is feasible, safe, and without adverse effects, providing an entertaining approach to rehabilitation.

Keywords: RehabRelive Active Glove, Conventional therapy, Fugl-Meyer Assessment of Upper Extremity, Hand dexterity

INTRODUCTION

Stroke is a significant cause of death and disability in developed countries and low-middle-income countries (LMIC), and an important global concern.(1) According to recent population-based research, the incidence rate of stroke in India is 119 to 145 per lakh.(2) Since India's life expectancy has lately risen to nearly 60 years, age-related, non-communicable diseases like stroke have become more prevalent, making them the country's fourth major cause of death and fifth leading cause of disability.(1)

Stroke negatively impacts patients' and their caregivers' quality of life (QOL).(2)At the time of the stroke, 85% of patients have deficits in upper limbs; three months later, 55% to 75% continue to have these

impairments.(3)For stroke survivors, hand motor impairment—particularly weakness and decreased voluntary movement control is the most prevalent impairment. This includes dextrous use of the hand in daily living activities.(4)

Several approaches are used in conventional physical therapy treatment to improve hand dexterity such as peg boards, beads activity, ring towers, block towers, and many more. Though these traditional rehabilitation treatments are found to be effective, many patients describe them as monotonous.(5)This could be due to a lack of immediate feedback, challenge, and inability to relate these treatments to any functional tasks.

Therefore, innovative and engaging rehabilitation programs that offer training that is not as physically demanding and put a strong emphasis on abilities like perceptual accuracy and reaction times are preferred.(5) Rehabilitation programs which include different types of gaming are especially an interesting research field as they provide customized experiences involving different sensory channels, commonly vision, hearing, and touch.(6) Many previous studies proved that tablet-based games can improve motor functions in patients with stroke.(7)(8)

RehabRelive active glove SE, manufactured by Galanto Innovations, India, is composed of lightweight material and contains bending sensors that record movements of the hand, wrist, and individual fingers through real-life-based game training. The manufacturer claims to offer repetitive training without having the assistance of a therapist. Furthermore, it can measure the range of motion of each movement produced, giving quantitative feedback as well. The software's Artificial intelligence-powered adaptive level control feature gives the patient individualized training based on their condition. Consequently, while the patient is performing a task in the game, they receive customized repeating task-specific training to improve neuroplasticity. It is quite challenging to explain the game to certain patients, since cognition is also affected in stroke patients.

It is challenging in conventional physiotherapy treatment to provide constant feedback on their performance and entertainment with exercise to the patient, which would discourage them from continuing exercise for long periods. There has been an increase in interest in using gaming as a rehabilitation program in recent years, as these systems would give motivation and entertainment to the patients.(5)So this study seeks to find the improvement after using the RehabRelive Active Glove device and compare it with the traditional physiotherapy treatment.

METHODOLOGY

This prospective, interventional study was conducted at the outpatient rehabilitation department of Government Physiotherapy College, Jamnagar. The ethical clearance is taken from the Institutional Ethics Committee of M.P. Shah Government Medical College and Guru Gobind Singh Hospital, Jamnagar, with

Reference project number 236/03/2023 under good clinical practice. Sample size was calculated using GPower software version 3.1 with effect size 0.8. Written consent was obtained from every participant or their respective legal representatives. A total of 39 patients were screened, out of which 24 were selected based on inclusion criteria. All participants were equally divided into experimental and control groups through a convenient sampling method. All participants received the assigned intervention for 16 sessions, 4 days a week. After 16 sessions of the participants' respective interventions, they were switched to another intervention for 3 sessions, after which a survey was conducted asking the participants which intervention they preferred to continue with their further rehabilitation.

PARTICIPANTS

The inclusion criteria for selected participants were (i)Subjects willing to participate in the study (ii)Ischemic/ Haemorrhagic stroke for >2 weeks (iii)Able to understand and follow verbal instructions (iv)Both males and females are included (v)Subjects having Fugl-Meyer Assessment for Wrist score at least 5 out of 10. The exclusion criteria were (i)Individuals with dysmetria, (ii)Individuals with visual or hearing impairment, (iii)Individuals with perceptual disorders, (iv)Individuals with impaired cognition, (v)Individuals with impaired sensation, (vi)Subjects having any other musculoskeletal or neurological condition except stroke.

INTERVENTION

The participants in the experimental group underwent 45 minutes of conventional physical therapy plus 15 minutes of glove therapy and 5 minutes of conventional hand treatment; whereas the participants in the control group underwent 45 minutes of conventional physical therapy plus 20 minutes of conventional hand therapy for 16 sessions. The RehabRelive active glove is free size and can be worn by any adult on either hand. The flexible finger bands allow free movements. Participants underwent three different games for 5 minutes each. The first game was Runman, which included the task of wrist flexion and extension, the second game was Squeeze, which emphasized finger flexion and extension movements, and the third game was Food Flip, which included the task of supination and pronation movements. A total of 7 sensors located at the wrist joint, metacarpophalangeal joint (MCP), and fingers monitor the movements of the hand, wrist, and fingers while the patient is playing different games and receiving visual biofeedback from the tablet. Through Bluetooth, information from the glove's sensors is sent to the tablet's application. After that, motion analysis is done, including the range of motion of the respective movements. Passive stabilization was required either by the therapist or a stabilizing belt at the proximal forearm level to minimize trick movements during the intervention. Conventional physical therapy included stretching of the tight muscles, strengthening of weak

muscles, weight-bearing exercises, balance, and gait training. Traditional hand exercises include peg board activity, ring tower, and functional peg board activities.

Figure 1: RehabRelive Active Glove device

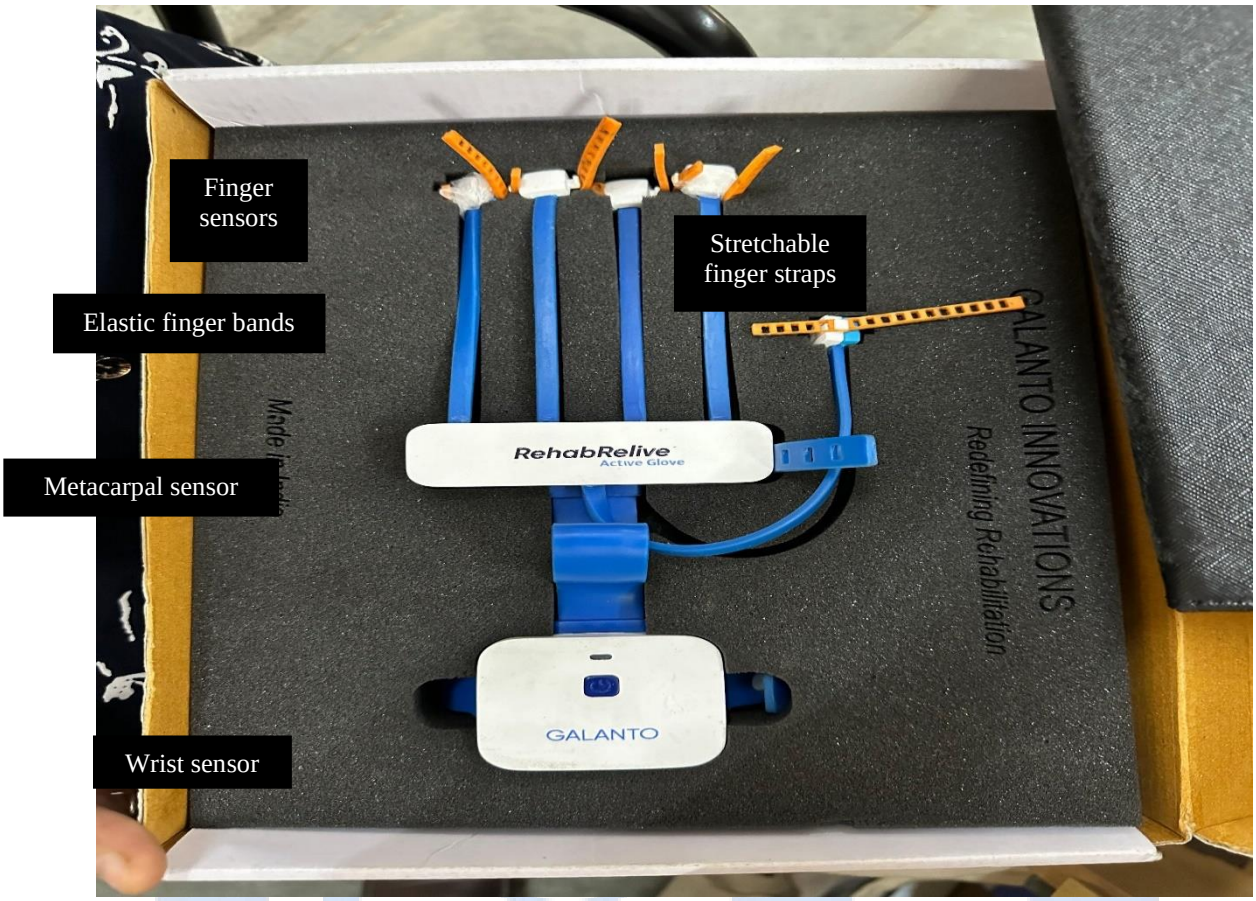


Figure 2: Patient playing Runman with RehabRelive Active Glove

Figure 3: Patient playing Squeeze with RehabRelive Active Glove

Figure 4: Patient playing Food Flip with RehabRelive Active Glove

OUTCOME MEASURES

The primary outcome measure was the change in the score of the Fugl-Meyer Assessment of Upper Extremity (wrist and hand component). It is the most frequently used outcome measure for motor impairment after stroke with excellent inter-rater reliability and validity in patients with stroke.(9)The secondary outcome measures were the box and block test(BBT), and the Chedoke arm and hand activity inventory. BBT is used to assess hand dexterity in stroke survivors. BBT is a quick, easy, and reliable test. Furthermore, high degrees of inter-rater ($r>0.9$) and test-retest ($r>0.9$) reliability are reported for both the right and left hands.(10)The Chedoke arm and hand activity inventory is found to be a more accurate measure to assess the upper extremity functional capacity of individuals with stroke having excellent inter-rater reliability.(11)

RESULTS

A total of 24 participants were finally selected for the study. All the participants were divided equally in both groups. One participant of the control group was lost to follow-up. Statistical analysis was done using SPSS version 25 Windows software.

Table 1 shows the baseline characteristics of participants of both groups. There is no significant difference in baseline characteristics between the experimental and control groups.

Table 1: Baseline characteristics of the participants(N=23)

Characteristics	**Intervention group(N=12)**	**Control group(N=11)**	**p-value**
Age (in years)	58.75	56.90	0.705
Gender			
Male	11	10	0.949
Female	1	1	
Affected side			
Right	9	8	0.901
Left	3	3	

Table 2 shows the mean value of all the outcomes before starting the treatment and comparison for the same is done by applying the independent t-test or Mann-Whitney U test. The results show that there is no significant difference between the two groups for the Chedoke Arm and Hand Activity Inventory (CAHAI) and the Box and Block Test. In contrast, there is a significant difference in the score of Fugl-Meyer Assessment of Upper Extremity (FMA-UE) finger and hand score between groups. The score of FMA-UE is higher in the control group than the experimental group.

Table 2: Comparison of mean values of outcomes between two groups before starting the treatment

OUTCOME	MEAN VALUE OF EXPERIMENTAL GROUP	MEAN VALUE OF CONTROL GROUP	p-value
FMA-UE	17.41	21.18	0.044
BBT	23.91	34.18	0.051
CAHAI	32.91	40	0.107

(FMA-UL=Fugl_Meyer Assessment of Upper Limb, BBT=Box and Block test, CAHAI=Chedoke Arm and Hand Activity Inventory)

Table 3 shows the mean values of all the outcomes taken before and after the treatment for the experimental group and the p-value according to the paired-t test or Wilcoxon signed rank test, which shows significant differences in all the outcomes of the experimental group.

Table 3: Mean outcome measures of the experimental group

Outcome	Mean value	p-value
FMA-UL		0.011
Pre	17.41	
Post	19.33	
BBT		0.001
Pre	23.91	
Post	31.50	
CAHAI		0.003
Pre	32.91	
Post	36.16	

(FMA-UL=Fugl_Meyer Assessment of Upper Limb, BBT=Box and Block test, CAHAI=Chedoke Arm and Hand Activity Inventory)

Table 4 shows the mean values of all the outcomes taken before and after the treatment for the control group and the p-value according to the paired-t test or Wilcoxon signed rank test, which shows significant differences in all the outcomes of the control group.

TABLE 4: Mean outcome measures of the control group

Outcome	Mean value	p-value
FMA-UL		0.038
Pre	21.18	
Post	21.81	
BBT		0.006
Pre	34.18	
Post	38.63	

CAHAI		0.04
Pre	40.00	
Post	42.00	

(FMA-UL=Fugl_Meyer Assessment of Upper Limb, BBT=Box and Block test, CAHAI=Chedoke Arm and Hand Activity Inventory)

Table 5 shows the mean difference of the values of all the outcome measures taken before and after the treatment of both the groups and their p values according to the independent t-test or Mann-Whitney U test that shows no significant difference between the experimental and control groups.

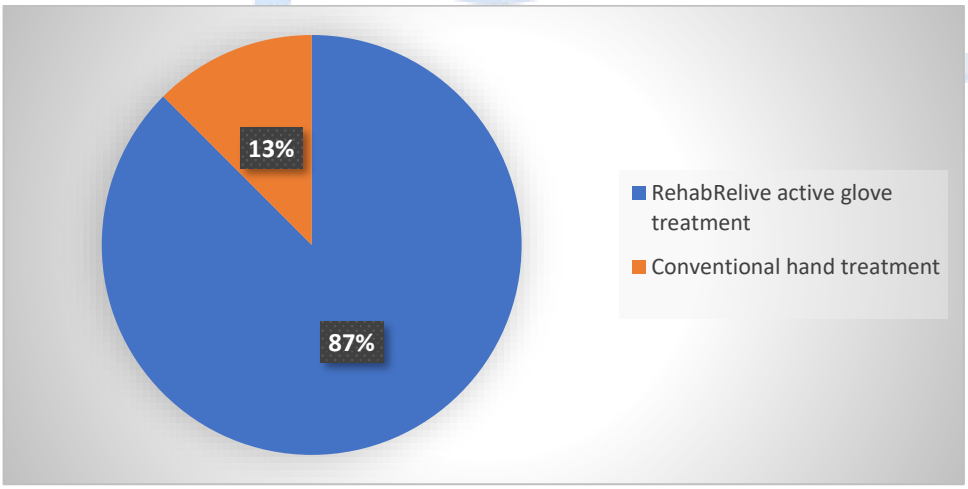
Table 5: Mean difference of outcomes of both groups

Outcome	**Mean difference of experimental group**	**Mean difference of control group**	**p-value**
FMA-UL	1.92	0.63	0.104
BBT	7.58	4.45	0.166
CAHAI	3.25	2.00	0.069

(FMA-UL=Fugl_Meyer Assessment of Upper Limb, BBT=Box and Block test, CAHAI=Chedoke Arm and Hand Activity Inventory)

A survey was done on all the participants by asking them which method of treatment they enjoyed the most and would prefer for further rehabilitation. The result of this survey is demonstrated in chart 1. The chart shows that 87% of participants wanted to continue their treatment with RehabRelive active glove treatment while 13% wanted to move further with conventional hand treatment.

Chart 1: Preferred treatment option



DISCUSSION

The results of this study showed that RehabRelive active glove therapy showed improvement in all three outcome measures, which confirms the efficacy of glove therapy. However, there is no statistically

significant difference found between the comparison of the intervention group with the control group. Hence, it can be concluded that RehabReliveactive glove therapy is as effective as conventional therapy if not more.

Our study results do not support the study done by Shin, et al.(2016), using a similar smart glove, which showed that the smart glove was superior to conventional occupational therapy in improving upper-extremity function and quality of life in patients with chronic stroke.(12)The explanation for the contrasting results is the difference in total duration of intervention, the difference in outcome measures, and method of analysis. The results of this study did not match with another study done by Kang, et al.(2020) using a similar active smart glove which concluded that smart glove treatment significantly improves the functional outcomes as well as the score of Fugl-Meyer Assessment of Upper extremity distal segment.(8)This may be due to the difference in the duration of treatment, inclusion criteria of both the studies, and the method of statistical analysis. Unlike the previous study, we did not use any functional movements as home treatment for the participants which explains the difference in results of the ADL outcomes.

Motor learning principles could be the foundation of the experimental group's potential improvement process. It is well recognized that practice and feedback are crucial for motor learning during physical therapy treatments. Intrinsic feedback was provided to the patients by the screen of the tablet as well as from muscles, joints, and tendons. Extrinsic feedback in the form of directions from the therapist further enhances motor performance.

This study has several limitations. First, long-term follow-up was not taken. Second, the timing of RehabRelive active glove treatment was kept at 15 minutes, based on the endurance of the participants, as they received 45 minutes of conventional physical therapy before the glove treatment. Third, one participant from the control group lost to follow-up. Fourth, no blinding was done either on the therapist or participants. Fifth, there is a significant difference in the score of FMA-UE between the two groups before the start of the treatment.

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

CONCLUSION

RehabRelive active glove therapy is as effective as conventional hand therapy in improving hand function in stroke patients. RehabRelive active glove therapy is feasible, safe, and without any adverse effects providing an entertaining approach to the treatment. The result of the survey supports the above statement. This study forms the base knowledge for conducting larger clinical trials.

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