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Effect of Physiotherapy Intensification on Patients' Post-Stroke Results

Nauwaf Ali M. Almushaiqeh[1]*, Eman Mohammed S. Alansari[2], Bandar Abdulmohsen Alsada[3], Shuruq Meshal Alharthi[4]

[1] Physiotherapist, PSMMC

Email- nawaf.at20@gmail.com

[2] Pharmacy Technician, PSMMC

Email- Emanm2437@gmail.com

[3] Physiotherapist, PSMMC

Email- Bndar161@gmail.com

[4] Physical Therapy Intern, King Khalid University Hospital

Email: Shroog202009@gmail.com

Abstract - This research examines how a proposed increase in the intensity of physiotherapy for stroke patients in Saudi Arabia affects those patients' long-term outcomes. Our goal was to examine the effectiveness of CP in conjunction with a VR system designed to target the LE and to determine whether or not this therapy was feasible and clinically effective for patients. We also aimed to evaluate how this system might influence motor skills, gait, balance, and trunk control in post-stroke patients. Findings show that post-stroke functional improvement in LE and gait is greater when a VR therapy is applied, with the help of enhanced feedback, than when the same amount of CP treatment is used.

Keywords - Physiotherapy Intensification, Effect, Post-Stroke, Patients–

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INTRODUCTION

Stroke is a leading cause of disability and death worldwide. Stroke ranks third in terms of fatalities and as the major cause of long-term disability in the UK. Roughly 130,000 people every year have their first stroke. Effective preventive and rehabilitation measures are essential in addition to broadly applicable pharmaceutical therapy for acute stroke. An important task for 21st-century medicine is the creation of such methods [1].

The role of exercise and physical activity in the main and secondary prevention of stroke, as well as in stroke recovery, is being more supported by research. Clinicians, therapists, and epidemiologists alike are interested in the intricate relationship between physical exercise and cerebrovascular illness. The significance of the connection is becoming clearer: the INTERSTROKE research has linked physical inactivity as one of the 5 primary risk factors that account for more than 80% of the worldwide burden of stroke [2]. A growing amount of research demonstrating the advantages of physical fitness training in enhancing function after stroke has led to its widespread recommendation as an integral part of stroke rehabilitation regimens. Less certain is the function of long-term physical exercise in the prevention of future stroke in people who have already had a stroke.

Systematic research has shown that organized multidisciplinary care and rehabilitation after stroke enhance patient survival and independence, as well as reducing the length of inpatient stay [3].

However, the exact mechanism by which dedicated stroke units improve upon standard treatment remains unknown. Several factors have been attributed to the success of the treatment provided in these settings. Skilled nursing care; early development of rehabilitation plans including carers; early evaluation and planning for release requirements; and full assessment of medical conditions, impairments, and disabilities. The field of physical therapy, often regarded as an important component of comprehensive stroke treatment, is linked to many of these elements.

Seven out of every hundred community-dwelling stroke patients may benefit from outpatient therapies like physical therapy, according to a recent Cochrane analysis of 14 studies [4].

Physical therapy for stroke survivors primarily aims to help patients regain motor control in gait and gait-related tasks, improve upper limb function, learn to adapt to their new limitations in ADL, and increase their level of engagement in life. Physical therapists not only use exercises to improve mobility, but also gadgets like treadmills and electronics to aid in rehabilitation [5]. Complications, such as falls and shoulder soreness, may be avoided if the patient, family, and stroke team follow the advice and instructions given. Physiotherapists now more than ever before understand the value of evidence-based medicine as a framework for making in-clinic decisions. The effectiveness of physical therapy therapies for stroke, however, has not been described in a systematic study [5-7]. The purpose of this study was to determine whether physical therapy approaches have been shown to improve functional outcomes after stroke.

Recovery from stroke

Stroke recovery is generally divided up into stages. After a stroke, the first 24 hours are considered hyperacute, the following 7 days are acute, the next 3 months are subacute, the next 6 months are late subacute, and the last 6 months are chronic, as recommended by the Stroke Roundtable Consortium. This categorization is informed by the knowledge that the means by which people recover from stroke evolve over time. In the hours after the onset of brain ischemia, a cascade of plasticity-enhancing mechanisms causes dendritic elongation, axonal sprouting, and synapse formation. Recovery from motor symptoms, in particular, tends to peak during the first few weeks following a stroke and then level out by three months. Insufficiency that lasts longer than six months is chronic and not expected to get better without treatment. However, even in the chronic phase, training or other interventions may be possible to rectify some deficiencies induced by stroke, especially in more[8] cognitive areas like language.

But if recovery is broken down into discrete steps, researchers can get the incorrect idea and conclude that recovery after a stroke follows a linear path when in fact it is a non-linear process that unfolds over time. Although those at 10 days and those at 80 days post-stroke are both classified as belonging to the early subacute phase, it is likely that recovery-related processes vary considerably between the two time points. It's unclear whether the same principles underpin recovery at all stages since some people recover more rapidly and efficiently than others. Instead of using terms like "subacute" or "chronic," which often implicitly indicate a particular potential for improvement, it seems more appropriate to provide absolute numbers on time from stroke onset, e.g., weeks, along with additional information about the level of impairment and the location of the stroke [9-11].

Imaging stroke recovery

Neuroimaging techniques provide a noninvasive window of opportunity to study the neurological underpinnings of functional rehabilitation in individual individuals. fMRI has helped us learn a great deal about the brain circuits responsible for recovery and recovery after stroke. fMRI investigations in persons who have had a motor stroke have shown that the two halves of the brain exhibit distinct patterns of activity: lesional and contralesional. Stroke victims often show increased activity in the contralesional sensorimotor region while using the unaffected side of the brain to perform unilateral activities [12-15]. During the first week following a stroke, people with more severe initial deficits are more likely to engage the contralesional hemisphere [16-18].

Interference with stroke recovery

Improved neuroplasticity via training aids in the reorganisation of stroke-affected brain areas. Functional rehabilitation may benefit from both time-tested training-based treatments like physical, occupational, or language therapy and cutting-edge multimodal approaches like mirror therapy and music-based therapy. Restoring neuronal activity is a promising strategy for healing stroke-related damage because of the strong correlation between neuronal activity and motor performance. Transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS) are two examples of non-invasive brain stimulation techniques that may influence neuronal plasticity (TDCS). TMS and TDCS have been shown to alter local brain activity, and there is some suggestion that these alterations may propagate to other connected brain sites and have a knock-on effect on activity at nodes across the network of the stimulated node. These methods may help correct the anomalies in network topology that are common among stroke survivors[16]. Repetitive transcranial magnetic stimulation at 1 Hz reduced contralesional M1 activity and fMRI over-activity in the stimulated area and the ipsilesional hemisphere in patients 2.1 months post-stroke (rTMS). When compared to what would have happened with sham or control stimulation, the resulting pattern of activation was more asymmetrical. When everything went back to "normal," the hand's motor function recovered. This "normalisation" of activity is related with a decrease in aberrant inhibitory effects from contralesional M1 for those with the greatest substantial motor improvement, as measured by connection tests. [19-24]

The length of time after the onset of the stroke and the intensity of the rTMS therapy also seem to be important factors. As an example, in patients with persistent motor impairments, a single rTMS block performed with intermittent theta-burst stimulation showed no behavioural impact at the group level. [25-29] The efficacy of rTMS to elicit a response was very restricted, despite connections between the strength of ipsilesional M1 connection and variations in behavioural aftereffects among participants. For this reason, some stroke survivors show remarkable improvement while others decline during the years after the event. It's possible that things will change quickly after a stroke if endogenous plasticity has already been triggered. In the early stages of recovery after a stroke, ipsilesional activity decreases as well. Therefore, it is reasonable to hypothesise that stimulating ipsilesional M1 quickly after stroke start, especially by repetitive stimulation, is beneficial for post-stroke recovery. With the use of rTMS, an iTBS regimen, and motor training, Volz et al. aided patients in recovering after their first stroke. One group got 5 days of stimulation, whereas the other received sham stimulation, during the first two weeks following a stroke (on average, 7.3 3.6 days). After one week of treatment, patients in the M1 stimulation group had larger improvements in grip strength compared to those in the control group. [30-34]

Future perspective of Recovery from stroke

The use of functional neuroimaging has greatly improved our comprehension of the neural pathways responsible for post-stroke functional recovery and the enhancements brought about by brain stimulation. Variation in treatment and recovery outcomes after injury or disease may be explained by data from brain imaging studies, such as connectivity. Also, state-of-the-art approaches for analysing fMRI data, such as dynamic functional connectivity, allow for investigation of temporal network dynamics after stroke and their connection to motor dysfunction. To successfully treat the dysconnectivity of certain nodes in a network, we currently need a personalised technique that takes into account an individual's unique network pathology. In an effort to foresee the severity of motor impairment or motor outcome, researchers have looked at fMRI data collected during the first week following stroke and used multivariate machine learning algorithms to the data. The diagnostic accuracy of individual predictions generated by a single MRI network is, however, still up for debate. [35] The large sample of patients (n = 100) analysed between 1 and 2 weeks post-stroke reveals that resting-state functional connectivity predicts roughly 45% of motor deficits, while lesion topography explains around 20% of the diversity found in post-stroke motor symptoms. Consequently, the total prediction ability is still unsatisfactory at the level of a single patient, despite these wide projections. For everyone concerned with stroke, the issue of whether or not (f)MRI is the best method for predicting a patient's prognosis and recovery is of the utmost importance. Patients, particularly those who have had a stroke, often suffer from small or big artery disease that restricts blood flow, compounding the difficulty of head motion required for fMRI scans. This suggests that a significant proportion of people will exhibit fMRI data that is erroneous. In addition, those who are very unwell are seldom included in fMRI studies. Obtaining informed permission from such individuals and the massive medical and logistical effort necessary to evaluate them may both contribute to their underrepresentation in the data. [36-38] Most of our assumptions and results on stroke recovery are skewed towards individuals with minor impairments since it is still debatable whether the same adaptive or maladaptive neural pathways apply for persons with severe, long-lasting brain damage. Research into the electroencephalogram (EEG) has had a renaissance in recent years as a result of developments in recording and processing methods. High-density EEGs were obtained by Bonstrup et al. from hemiparetic patients within 5 days of their stroke as they performed an isometric, visually guided, whole-hand grip exercise. Researchers found that low-frequency oscillations during movement preparation returned in tandem with hand motor recovery, with greater increases in patients making a bigger recovery. [39] This measure has the potential to be a temporally sensitive biomarker of regained brain function that might be utilised to direct therapeutic procedures such as deep brain stimulation. [40-42]

Similarly, high-density electroencephalography (EEG) in conjunction with transcranial magnetic stimulation is a non-invasive perturb-and-measure method that shows both local neuronal states and signal propagation at the functional network level (TMS). Therefore, even for patients with severe illnesses, this approach shows potential as a non-invasive network readout that may be performed at the bedside. Tscherpel et al. discovered that motor impairment and recovery were linked to early evaluations of TMS-evoked EEG responses more than three months after a stroke. TMS-EEG demonstrated distinct patterns of response that were linked with full recovery, enabling for differentiation between people who were otherwise indistinguishable based on phenotypical/clinical presentation alone. [35] This demonstrates the enormous potential of the approach as a novel readout of the motor network's functional reserve. TMS-EEG characteristics were significantly associated with stroke symptoms or outcomes in other investigations. To determine whether or if this method can provide reliable (i.e., outside-of-sample)

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recovery predictions, more research with larger samples is required. [43]

MATERIALS AND METHODS

Patients

This study was done on the Patients hospitalised to a neurorehabilitation hospital served as the research population, all of whom had been diagnosed with CVA in Saudi Country. Twenty patients were split evenly between two groups: virtual reality (VR) with cognitive remediation (CP).

The hospital's ethical committee and the university's institutional review board both gave their stamp of approval to this research. A pair of physiotherapists who were unaware of the treatments completed all of the pre- and post-testing. All of the essential virtual reality-based treatments were administered by a single physiotherapist with expertise in both neurological physiotherapy and virtual reality. It was in one of the hospital's private, quiet rooms set aside for one-on-one care where the assessments and treatments took place. Prior to the first examination, the majority of the patients who were chosen were already participating in physiotherapy.

Outcome Measures

To cut down on potential bias, we had the same physiotherapist do both the initial and follow-up assessments for each patient. For the purpose of measuring treatment safety, we kept track of both the incidence of adverse events and the number of treatments that were lost.

Interventions

Individuals took part in a treatment regimen that included 15 CP sessions such as 1 hour in one day and 5 days in a week. Previous research shown that a multifaceted CP intervention was superior to either a single therapy or a placebo control in facilitating functional independence following a CVA, hence this treatment regimen has been kept as a standard of care.

In addition to 1 hour of VR treatment focused on the LE every day, patients in the VR + CP group also performed 2 hours of CP, whereas patients in the CP group also did 2 hours of CP. In both groups, physiotherapists were present during the whole intervention period to ensure that the physiotherapy programme was adapted to the patients' individual motor abilities and demands VRRSR (Virtual Reality Rehabilitation System. Khymeia Group, Noventa Padovana, Italy) was used to provide the VR therapy. This system consisted of a computer ("working station"), a 3D motion capture system ("big screen"), and a high-definition LCD projector (Colchester, VT, USA).

As part of their VRRS treatment, patients engaged in a variety of motor tasks while interacting with a virtual scenario in which their LE's movements were tracked by a motion capture system, which then guided the LE's kinematic trajectories of movement during the various tasks using real-world references (such as stairs, shelves, signs, etc).

Statistical Analysis

Statistics were used in each case to examine demographic and clinical characteristics. The means and standard deviations were utilised to characterise the whole patient sample, while the median and interquartile ranges were employed to describe the two distinct patient cohorts (IR).

Due to the lack of parametricity among the variables and the relatively small sample sizes, we opted for a non-parametric method to do group comparisons (Shapiro-Wilk 0.05). Before the intervention, the Mann-Whitney U-test was performed to compare the two groups. For this reason, we looked at whether there were statistically significant variations in the groups' baseline scale scores before to commencing the physiotherapy treatment. The Wilcoxon test was used to compare the two groups of patients among themselves, revealing which measures showed statistically significant improvements after the intervention.

RESULTS

Figure 2 is a Boxplot representation of the mean scores of each group before and after therapy. Before and after treatment scores on each scale, as well as statistical data, were supplied as supplemental material (Tables 1).

Table 1: Demographic data

Patient's ID	Age in Years	Gender	Post-Stroke Months	Stroke Type	Stroke Hemisphere
1	74	Man	2.03	Ischemic	Left
2	77	Man	10	Ischemic	Left
3	64	Man	4.7	Ischemic	Right
4	58	Man	7.3	Hemorrhagic	Left
5	50	Man	2.8	Hemorrhagic	Right
6	59	Man	4.6	Ischemic	Right
7	59	Man	10	Ischemic	Left
8	45	Man	18.3	Ischemic	Right
9	68	Man	5.1	Hemorrhagic	Left
10	73	Man	4.1	Hemorrhagic	Right
11	76	Woman	6	Ischemic	Left
12	59	Woman	1	Ischemic	Left
13	65	Man	1.4	Hemorrhagic	Left
14	56	Woman	1.1	Ischemic	Left
15	69	Man	1.4	Hemorrhagic	Left
16	29	Woman	0.8	Ischemic	Left
17	62	Man	4	Ischemic	Left
18	59	Man	7.5	Ischemic	Left
19	67	Man	3	Ischemic	Left
20	80	Woman	1.5	Ischemic	Left

Note: (VR + CP: 1–10; CP: 11–20)

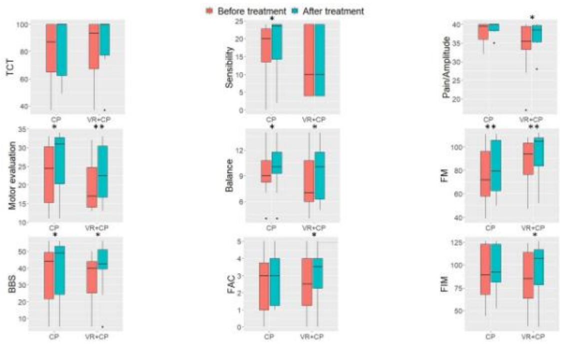

Figure 1: Boxplots showing the distribution of patient ratings on each scale for the two groups.

Berg Balance Scale = BSS; Fugl-Meyer = FM; Functional Ambulation Category = FAC; Functional Independence Measure = FIM; Trunk Control Test = TCT. * $p < 0.05$, ** $p < 0.01$.

Before the intervention, there were no significant differences on any of the measures when comparing the two groups. Because of this, we may assume that their initial clinical condition is equivalent. In terms of therapeutic efficacy, most scales show general increases for both options (Figure 2).

Wilcoxon tests revealed that towards the conclusion of the intervention, the CP group had substantially higher scores on the BBS, FIM scales and FM (total score), as well as the FM-subscales sensitivity, motor assessment, and balance.

Non-significant improvements were also seen after the intervention on measures including FAC & FM and TCT amplitude/pain.

Additionally, all scales (with the exception of sensitivity and TCT) showed statistically significant improvements for the VR + CP group. In addition, this population showed a high level of treatment satisfaction at the conclusion of the intervention (Median = 56.5, IR = 53.5-60).

CONCLUSION

Results show that combining VR treatment with CP improves LE and gait recovery after stroke via increased feedback. VR treatment is feasible, as it has been demonstrated to enhance joint range of motion and decrease pain, both of which may play a role in the observed functional enhancement. Although there were no significant differences in trunk control between the two groups, substantial improvements were seen in balance and motor function. This lends additional evidence to the value of intensive physiotherapeutic treatment in CVA patients. In order to maximise its benefits, CP might benefit from a VR system designed specifically for physiotherapy. When it comes to meeting the unique needs of post-stroke patients, the physiotherapist plays a pivotal role in the introduction and adjustment of these cutting-edge systems, which contain adaptive software and hardware.

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Corresponding Author

Nauwaf Ali M. Almushaiqeh*

Physiotherapist, PSMMC