Efficacy of Virtual Reality Induced Environmental and Habitual Navigation on Psychological, Cognitive Function that Impacts on Physical Recovery in Patients with Stroke

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Abstract

[Background] Cognitive dysfunction after a stroke is normal, but it is underdiagnosed and has a bad prognosis. In 40-70 percent of stroke survivors, there is a degree of cognitive dysfunction. Similarly, psychometric issues such as anxiety and depression are normal following stroke but are mostly untreated, resulting in a patient's poor quality of life. Whereas it also has an effect on a person's rehabilitation. The use of traditional methodology has certain beneficial effects, but it is not necessarily handled with the individual's own interests in mind. Virtual reality, on the other hand, seems to play a role in dealing with such issues, especially where they are linked to neurological disorders. Virtual reality navigation has the potential to enhance basic cognitive functions such as visuo-spatial perception, executive performance, and attention, both of which can affect one's psychological state and aid in functional rehabilitation. Cognitive deficits and social issues must be addressed because they have a detrimental impact on functional abilities and quality of life.

[Methodology] Twenty-three participants between the ages of 40 and 60 with a stroke diagnosis were chosen. Participants were split into two groups: Group A, which received Virtual Reality induced environmental and habitual navigation as well as Conventional Physiotherapy, and Group B, which received Conventional Physiotherapy as well as cognitive training and relaxation for 4 weeks of duration. The Montreal Cognitive Assessment (MoCA), Hamilton Anxiety Rating Scale (HARS), Hamilton Depression Rating Scale (HDRS), and Functional Independence Measure (FIM) were used to conduct pre and post intervention evaluations.

[Conclusion] The study found that combining virtual reality-induced environmental and habitual navigation with conventional physiotherapy improves cognitive control, psychological function, and functional recovery in stroke patients more effectively than treating them with conventional physiotherapy alone.

Key Words: *Anxiety, Cognitive Impairment, Depression, Environmental Navigation, Functional Recovery, Habitual Navigation, Stroke, Virtual Reality.*

Introduction

Stroke is the most popular classic problem. In the past, ancient Indian physician "Sushrutha," also known as the "Father of Surgery," referred to stroke as "pakshavada." Around the time of Pericles, around 400 B.C., the Greek physician Hippocrates, also known as the Father of Medicine, coined the term "apoplexy." (1)

William Cole invented the word "STROKE" in the late 17th century, specifically in the year 1689. As a result, stroke has been around for a long time, and many doctors have struggled to describe stroke in its history. Stroke was identified as "rapidly developing clinical

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symptoms of focal or global disruption of cerebral function, lasting more than 24 hours or leading to death" by the World Health Organization in 1970. [2]

Stroke is a significant cause of disability and death worldwide; Stroke are classified on the basis of its etiologies as either ischemic (85%) or hemorrhagic (15%). Ischemic stroke is the most common form, and it is caused by a blockage of blood flow to a specific region of the brain. Four subtypes have been identified (atherosclerosis, lacunar infarcts, cardioembolic, cryptogenic). Hemorrhagic strokes, which are caused by the bursting of a blood vessel. Intracerebral haemorrhage (ICH) and subarachnoid haemorrhage, which account for around 5% of all strokes, are the two major forms of haemorrhagic strokes. [3]

In 2010, the global prevalence was 33 million. Despite the fact that the death rate of stroke has decreased by 35.8% in the last decade, nearly 795000 people in the United States still suffer from a stroke. [5] 4 According to recent population-based reports, the incidence rate is 119-145/100,000. Every year, 800,000 new strokes occur in the United States. According to an epidemiological survey, the incidence of stroke in China ranged from 116 to 229 per 100,000 person-years, leaving around 75% of people with motor impairment and 40% with serious disability. India, like many other developing nations, is dealing with a double burden of communicable and non-communicable diseases. The median adjusted prevalence rate of stroke in rural areas seems to be 84-262/100,000, although in urban areas it is 334-424/ 100,000. Every 40 seconds, a new stroke is rendered. [4][5]

The neurological signs and symptoms of an ischemic stroke typically arise immediately, but they can also appear gradually. The most common symptom is sudden onset of hemiparesis in an elderly person. Symptoms and symptoms differ depending on where the occlusion is located and how much collateral flow is present. [9] Neurological symptoms such as limb paralysis, trouble communicating, vision impairment, or a sudden unexplained headache may occur prior to a haemorrhage caused by an enlarging aneurysm putting pressure on the surrounding tissue or a blood leak into the subarachnoid space. [9][10]

Cognitive dysfunction after a stroke is usual, but it is underdiagnosed and has a poor prognosis. In 40-70 percent of stroke patients, there is some degree of cognitive disability. Cognitive impairments are classified into many categories, including: concentration, memory, and executive function (Focus attention, sustained attention, selective attention, and divided attention), recollection (Visual memory, auditory memory, working memory, episodic memory, semantic memory, working memory, and procedural memory), Role of the Executive (Initiation, processing speed, problem solving, planning), Perception and application (Visuo-spatial, visuo-perceptual, Unilateral neglect, inattention, apraxia, agnosia, prosopagnosia), Language impairment like Broca's, Wernicke's, transcortical motor/sensory or mixed, conductive, global aphasia. [13] According to current research, if patients are examined during the stroke phase, up to two-thirds of them will have cognitive impairment. Patients with post-stroke cognitive dysfunction have diminished performance, are more distressed, and have a higher mortality rate. It's a hidden expense and it's easy to overlook if you're not looking for it.[14]

More so when we consider all of this impairment after a stroke, which makes it more difficult for a person to have a successful physical recovery, affecting the patient's coping capacity to recover with regard to social support and a positive attitude about his progress, causing the patient to become irritated, give up, and negatively impacting his overall health. [15] In contrast, following a stroke, particularly in the right hemisphere, a variety of psychological changes can occur, the most common of which are depression and anxiety. [19] Furthermore, previous research suggests that post-stroke anxiety is widespread and long-lasting, and that this is due to a sense of powerlessness and confusion about the future. [20] As a result, the mainstay of post-stroke patient care should be a proper psychometric assessment. There is a connection between cognitive processes, emotions, and anxiety, according to evidence. [18]

Physiotherapy can be considered a good approach to overcome the determining problems, the use of the more active extremities in a functional training strategy promotes synaptic reorganization in the brain. Low-intensity recovery will begin as soon as the patient is medically stable, which is usually within 72 hours. Early on, popular traditional therapy focuses on physical aspects such as stretching, AROM, and PROM exercises to enhance flexibility and joint integrity, tonal management, and positioning techniques. Rolling, supine to sit and sit to supine, bridging, sitting, sit to stand and sit-down transitions, standing, and modifies are all examples of functional training exercises to enhance postural balance and functional mobility. Depending on the severity of the stroke, plantigrade can also recommend interventions to enhance upper and lower extremity functions, as well as balance training. Although relaxation technique may be considered a useful tool determining a positive emotional and psychological wellbeing. [17]

Virtual reality (VR) and immersive video games have emerged as promising therapeutic approaches in stroke recovery in recent years, both for cognitive rehabilitation and the treatment of mood and anxiety disorders. Several writers have used Virtual reality-based therapy for stroke rehabilitation, utilizing the features of the technology. [21] Virtual Reality is the use of immersive stimuli generated by computer hardware and software to allow users to communicate with a virtual world that looks and feels natural. VR has been shown to relieve stress and improve mood in those who live in isolated cramped environments by providing exposure to nature. [20] With recent advancements in interactive technologies, a lively virtual space interface could be developed where the world attracts the participant patient's interest as a ground-breaking way to overcome the challenges of conventional therapeutic stroke therapy. [23] [20]

The aim of this research is to test the results of a hybrid rehabilitative technique, using virtual reality induced environmental and habitual navigation in various environments with the skill of self and automatic navigation and relaxing in the virtual reality, which is accomplished by a head mounted virtual reality interface to provide a 360-degree live immersive experience for a stroke patient.[20][23][24] This could allow for improvements in psychometric parameters such as anxiety and depression, which could help enhance the impaired cognitive realm as well as the physical rehabilitation of the affected patient in stroke patients. [20]

Materials and Methodology

Study was conducted in the In-patient department (IPD) Of Medicine Pravara Rural Hospital and Department of Neuro physiotherapy, Dr. APJ Abdul Kalam College of physiotherapy, PIMS, LONI. The sample was collected from Department of Medicine, Pravara Rural Hospital Loni. The Duration of the study was 2 Years. Study design of the study was Pre-post experimental study. Sample size for the study was calculated and was 20 participants, which were divided into two groups, 10 participants in group A and 10 participants in group B. Sampling method used was simple random sampling. Study population which was included in the study was Acute Stroke population. Participants admitted under condition of stroke, acute in condition at Pravara Rural Hospital**,** PIMS, Loni. were allowed to participate for the study.

EQUIPMENT USED: - Virtual Reality Device (Type: Headset, Head mounted device)

Fig.1

Selection Criteria: -

Inclusion criteria: -

1) Both male and female participant. 2) Participant age group above 40 to 60 yrs. 3) First episode of unilateral stroke with hemiparesis. 4) Patient who are diagnosed with investigating reports of Acute stroke on computed tomography (CT) or Magnetic Resonance Imaging (MRI) 5) Ability to follow instructions and perform the exercise programs. 6) Patients who are willing to participate.

Exclusion criteria: -

1) Patients with any Visual Impairment viz. Hemianopia, Neglect, Diplopia, Reduced Visual acuity, ptosis, Anisocoria and Nystagmus. 2) Patients with Significant musculoskeletal abnormalities or pain, cardiovascular disease, or respiratory disease that would interfere with study procedure or affects safety. 3)Patient with severe cognitive impairment.

Procedure

The study received ethical clearance from the Institutional Ethical Committee (PIMS/CPT/IEC/2020/72). All the participants referred were screened according to the inclusion and exclusion criteria. The informed written consent was obtained from the participant regarding the procedure prior to the study. 23 participants with acute stage of stroke were screed included in the study. The participants were screened and after finding suitability according to the inclusion and exclusion criteria, they were requested to participate in the study. They were explained about the study and the intervention. The participants were briefed about the nature of the study, duration of intervention and the intervention being used and were explained in the language best understood by the participants. The demographic data was obtained and the detailed assessment was done. The sample size of the study was 23 participants. Where 23 participants participated in which the patients were divided into 2 groups. Group A and Group B.

Where experimental Group was given Conventional Rehabilitation and VR induced program with Environmental and Habitual training – 4 wk. (45 min/d, 4 days/wk.) Which included Environmental Navigation and Habitual Navigation i.e., at the first week of training the navigation was performed using joystick by the therapist and navigating in different environment viz. Park and under water scene, further when the patient was comfortable navigation was automated with the normal walking speed where patient has to focus on the environment and remember the environment and the place and get familiar with it in which environment like FARM walk, Village walk and Temple scene where used to navigate in the virtual space. Lastly when the patient was comfortable after a week self-navigation in sitting standing and walking where the patient was himself supposed to move with the environment in control, where the environmental scene was Temple, Village and a traffic spot. Task like active exercises of UE and LE were added with navigation when the patient was easily able to navigate by self. After each navigation a virtual relaxation environment was presented where the patient has to relax in the soothing relaxing environment with calming sound.

Group B was given Conventional rehabilitation and program which includes for -4 wk. (45 min/d, 4 days/wk.) The patients were asked to sit or lie comfortably on a bed, with the therapist standing on the affected side. The movement was driven by cueing (verbal and

motor). Passive range of motion, Active Assisted range of motion, and Active Assisted range of motion were used in the physical activities for the upper and lower limbs, respectively. For enhancing postural control and functional mobility strategies such as rolling, pelvic bridging, supine to sit, sit to supine, sit to stand, standing, transfers, and assisted walking, facilitation techniques such as short stretches, heavy joint compressions, and Proprioceptive Neuromuscular Facilitation (PNF) were used. Mat activities included prone on elbow, prone on side, and quadripod. Language training (alphabet, sentences, and numerical), colours recognition, picture and number identification, and drawing figures were all part of the cognitive training. As the patient's condition improved, gait and locomotor retraining, as well as balance retraining, were provided. Each patient received 45 minutes of counselling, with rest periods in between.

Before treatment pre assessment was done and after 4 weeks post assessment was done. Then all the participate were tested with, Hamilton Depression Rating Scale, Hamilton Anxiety Rating Scale for Psychological status. Montreal cognitive assessment Scale (MOCA) for the Cognitive functions and Functional Independence Measure (FIM) for Physical Recovery.

Outcome Measures: -

Participants are assessed by using scales which was calculated before and after the interventions:

1) Montreal Cognitive assessment Scale.

2) Hamilton Anxiety Rating Scale.

3) Hamilton Depression Rating Scale.

4) Functional Independence Measure

DATA ANALYSIS AND RESULT

Age distribution in group A and B

The average age of Group A (Virtual Reality + Conventional Physiotherapy) was 54.2 ± 6.25 years and in Group B (Conventional Physiotherapy) was 52.7 ± 6.89 years.

Gender distribution in group A and B

There were 7 male and 3 females in Group A and, receiving Virtual Reality and Conventional Physiotherapy and in Group B, there were 5 males and 5 females receiving Conventional Physiotherapy. The duration of treatment in both the groups was for 4 weeks.

Comparison of post-intervention and post-intervention values of Montreal Cognitive Assessment Scale in group A and B

Table no 1: Comparison of post-intervention and post-intervention values of Montreal Cognitive Assessment Scale in group A and B

Post Intervention	Group A		Group B		Unpaired „t" test value	„p" value	Result
	Mean	SD	Mean	SD			
MOCA	10.1	4.533	7.6	3.627	1.362	0.1901	Not significant

Post intervention MOCA score for Group A and Group B were 10.1 ± 4.533 and 7.6± 4.4 respectively. On comparison of Post-intervention MOCA mean scores between Group A andGroup B by using unpaired „t" test, it is observed that this difference is Not significant.With the reference of Table 1, Group A shows more scores in MOCA after 4weeks of duration than the Group B. ($p<0.1901$ and $t=1.362$ with $df= 18$).

Comparison of post-intervention and post-intervention values of Hamilton Anxiety Rating Scale in group A and B

Table no 2: Comparison of post-intervention and post-intervention values of Hamilton Anxiety Rating Scale in group A and B

Post Intervention	Group A		Group B		Unpaired „t" test value	„p" value	Result
	Mean	SD	Mean	SD			
HARS	7.9	3.315	8	2.390	0.07827	0.9385	Not significant

Post intervention HARS score for Group A and Group B were 7.9 ± 3.315 and 8± 4.4 respectively. On comparison of Post-intervention HARS mean scores between Group A andGroup B by using unpaired „t" test, it is observed that this difference is Not significant.With the reference of Table 2, Group A shows less scores in HARS after 4weeks of duration than the Group B. ($p<0.9385$ and $t=0.07827$ with $df= 18$).

Comparison of post-intervention and post-intervention values of Hamilton Depression Rating Scale in group A and B

Table no 3: Comparison of post-intervention and post-intervention values of Hamilton Depression Rating Scale in group A and B

Post Intervention	Group A		Group B		Unpaired "t" test value	"p" value	Result
	Mean	SD	Mean	SD			
HDRS	7.6	3.026	7.7	3.335	0.07022	0.9448	Not significant

Post intervention HDRS score for Group A and Group B were 7.6 ± 3.026 and 7.7± 2.39 respectively. On comparison of Post-intervention HDRS mean scores between Group A andGroup B by using unpaired „t" test, it is observed that this difference is Not significant.With the reference of Table 3, ($p<0.9448$ and $t=0.07022$ with $df= 18$).

Comparison of post-intervention and post-intervention values of Functional independence measure Scale in group A and B

Table no 4: Comparison of post-intervention and post-intervention values of Functional independence measure Scale in group A and B

Post Intervention	Group A		Group B		Unpaired „t" test value	„p" value	Result
	Mean	SD	Mean	SD			
FIM	88.6	8.501	74	10.165	3.484	0.0026	Very significant

Post intervention FIM score for Group A and Group B were 88.6 ± 8.501 and 74± 4.4 respectively. On comparison of Post-intervention FIM mean scores between Group A and Group B by using unpaired „t" test, it is observed that this difference is Very significant. With the reference of Table 4, Group A shows more scores in FIM after 4weeks of duration than the Group B. ($p<0.0026$ and $t=3.484$ with $df= 18$).

Discussion

This study was conducted to find out the effects of Virtual reality induced environmental and habitual navigation and conventional physiotherapy in between the groups on psychological, cognitive function and functional recovery in patients with stroke.

In the present study, MOCA, HARS, HDRS and FIM were obtained from the patients with stroke in both group A and group B. Before intervention data was obtained. Treatment was given to the patients according to their group and again after 4 weeks, data was collected in data sheet and comparison within the group and between these two groups was done.

The result of this study showed that MOCA score was increased in Group A significantly than Group B, HARS and HDRS score were decreased in both Group A and B, while FIM score were significantly increased in group A, after 4 weeks of intervention after comparing these scores with pre intervention scores by using paired, t'' test. It also revealed that after receiving the treatment patients showed more improvement in group A after 4 weeks of intervention.

Improvement in Montreal cognitive Assessment (MoCA):

The Montreal Cognitive Assessment was used in this analysis. It was founded in 1996 by Ziad Nasreddine in Montreal, Quebec. It was validated in the context of minor cognitive dysfunction and has since been clinically adopted in a variety of other environments. (32)(33)

Rosaria De Luca et al. investigated the impact of virtual reality on neuropsychiatric conditions after stroke, where psychological parameters such as anxiety and depression were measured in relation to cognitive function. The study found a slight increase in cognitive performance, especially attention, and the author stated that "nonetheless, only at the end of the training in immersive simulated world that is in the CAREN system, they observed substantial improvement in cognitive and behavioural functioning." While the simulated virtual world was just a minor aspect of the research, the patient's concentration systems, visuo-spatial skills, and executive functioning improved significantly. In addition, the report proposed that further trials be conducted to validate the therapeutic feasibility of these interventions in patient populations. (20)

In this study, virtual reality consists of Augmented three-dimensional universes with different landscapes i.e., different environments. Virtual reality is thought to enhance neuroplasticity and motor learning following stroke by activating brain areas involved in motor planning, learning, and execution. The study concentrates on stroke patients who had cognitive dysfunction and neuropsychiatric issues such as anxiety and depression which is tackled with Immersive environmental and habitual virtual reality navigation. (34)

Improvement in Hamilton Anxiety Rating Scale:

The Hamilton Anxiety Rating Scale (HAM-A) is a psychiatric assessment that physicians use to assess the level of anxiety in their patients. It was first published in 1959 by Max Hamilton. Clinicians often use the scale. For medicinal use only. The scale is regarded as a psychological rating of the extent of anxiety, where anxiety may refer to "an emotional condition, a drive, a reaction to a specific situation, a personality trait, and a psychiatric illness. Since it was one of the first anxiety rating scales to be issued, it was used to measure the psychiatric state of the patients in this report. (36)

Anxiety, according to Hoehn-Saric et al, is a biological alert mechanism that prepares us for action. During acute stress, anxiety is marked by a series of hormonal shifts in the body, autobiographical memory, the patient's past, and the social condition. According to certain research, relaxation and breathing techniques have a soothing and stabilizing impact on the autonomic

nervous system. While it is regarded as one of the most successful and beneficial approaches for stress and anxiety relief, there are no findings in the literature that show its efficacy in patients with stroke and neuropsychiatric symptoms. (20)

Calabro et al. have demonstrated that robot-assisted movement training with a robotic avatar would improve not only motor control (such as gait, posture, and muscle force), but also mood, perception, and coping strategies. Indeed, enhanced input during robot-assisted gait appears to be a promising method of not only promoting gait and physical activity, but also of improving psychological and cognitive status, especially in the executive phase. (20)

Similarly, De Luca et al. reported in their study that training in the immersive simulated world, i.e., the "CAREN System," resulted in a substantial change in cognitive and behavioural functioning. Indeed, when the psychometric tests were compared at the conclusion of the integrated method the patient showed significant change in concentration systems, visuo-spatial skills, and executive functioning. Furthermore, the result of De Luca analysis supports the use of the anxiety scale among people with stroke. Thus, the psychometric parameters are affected in consideration of stroke and also could be tackled through the virtual reality training, however, further research is needed to confirm these findings and examine the sensitivity of improvement in Anxiety Level. (20)

Improvement in Hamilton Depression Rating Scale:

The Hamilton Depression Rating Scale (HDRS) is a multi-item assessment used to assess depression and as a tool to measure rehabilitation. Max Hamilton first published the scale in 1960, and it was updated in 1966, 1967, 1969, and 1980. The questionnaire is intended for adults and is used to assess the seriousness of their depression by probing mood, remorse, suicidal ideation, insomnia, frustration or retardation, fear, weight loss, and somatic symptoms. (37)

Illness or accident can have an impact on your physical health, but it can also have an impact on your mental health. When people have a stroke, it causes a variety of signs and symptoms that result in the individual experiencing a series of impairments in later life. This reduces activity, makes the individual dependent on others for necessities, and lowers the quality of life, while also limiting people's occupational and social involvement. These ramifications will have a significant effect on social well-being. (42) Depression and anxiety are the most prominent mental health issues for stroke survivors. The person with stroke's key aim is to preserve a healthy quality of life and improve physical functional freedom.

Chang Hyung Lee et al. researched the association between stroke, cognitive tests, and depression in a paper, where they educated the patient with virtual reality, which supported the results of the current research, where depression scale was taken into account. This resulted in less depression in stroke patients, which improved their mood. (34)

Martina Maier et al. discovered that virtual reality experience decreased depression levels in the samples. That was attributed to the reduction of rumination, a recognized symptom of depression, according to the focus regeneration theory proposes, occurs when a patient effectively breaks away from repetitive physical and mental activities and moves from an effortful, directed concentration to an interest-driven attention, all of which was accomplished by creating an enjoyable environment that was sensory rich, coherently arranged, and allowed for exploration. Training-induced improvements in attention or memory may have resulted in a decrease in depressive levels in the study. Alternatively, the conditioning caused a mood shift, which led to functional development. (34)

Improvement in Functional Independence Measure:

The Functional Independence Measure (FIM) is a widely used functional measure in inpatient therapy that has been thoroughly researched and tested in this setting. It is one of the most commonly used devices in recovery

medicine for assessing disease and dependency. As a result, it was used in this study to measure the patients' functional rehabilitation. (39)

Inouye et al. used functional independence test ratings to assess factors influencing functional outcomes in stroke patients following inpatient care. Total FIM scores at discharge correlated positively with total FIM scores at admission and were negatively correlated with age and onset-to-admission interval, according to Spearman's rank correlation system (OAI). Total FIM scores at the time of admission were the best predictors of total FIM scores at discharge. The type of the stroke, gender, duration of hospital stays, and OAI, on the other hand, were not linked to total FIM scores at the time of discharge. Since the combined scores at admission and discharge is heavily correlated, the scores at admission will be used to establish a recovery regimen, notify the patient and family of the likelihood of success, and evaluate the volume and level of treatment provided in the home or discharge placement. (39)

Heruti et al. looked at improvements in Functional Independence Test scores in 315 stroke patients. a favourable relationship was found between increasing functional and cognitive FIM scores. A similar research looked at the relationship between neurological and motor defects and found that following a stroke, patients encounter deficits in a variety of tasks, from movement to speech and self-care. These restrictions have a detrimental impact on travel as well as the social and vocational facets of training. (41)

According to Arsic et.al, study on Functional Independence and Executive Functions, there is a correlation between mild cognitive dysfunction and functional independence. Stroke patients with cognitive disability have slightly lower degrees of mental freedom in all FIM domains than patients without cognitive impairment. (42)

According to the findings of the study, stroke patients with good executive functions have a higher level of functional independence in all tested realms, especially self-care and socialization. (41)(42)

Thus, the current research shows that virtual reality training caused by environmental and habitual navigation improved cognitive change in the experimental group rather than the control group. This research found that therapeutic and cognitive rehabilitation therapy had a good short-term effect in terms of functional recovery for stroke survivors.

Conclusion

The said study revealed that virtual reality induced environmental and habitual navigation training along with conventional therapy is more successful as compared with conventional therapy alone for the management of cognitive impairment especially Attention, Visuo-Spatial Execution, Conceptual Thinking and orientation which further enhances the impact on the psychological condition, it reduced psychological effects increased individuals coping ability which resulted in improved functional recovery during this time of Acute stroke condition, where a stroke patient normally experiences, i.e., Anxiety and Depression.

Limitation of Study

1. The study was conducted on patients with Acute Stroke Patients.

2. The study was conducted on acute stroke patients with the incidence up to 1 week-6 months.

3. The study included smaller sample study

4. The study was conducted on limited age group (40-65 years)

5. The intervention was done only for 4 weeks i.e., a short-term study

6. The study was limited to Pravara Rural Hospital.

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References

1. Thamburaj V A, textbook of contemporary neurosurgery, section 9, chapter 48, pageno 661.
2. Sacco RL, Kasner SE, Broderick JP, Caplan LR, Connors JJ, Culebras A, Elkind MS, George MG, Hamdan AD, Higashida RT, Hoh BL. An updated definition of stroke for the 21st century: a statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2013 Jul;44(7):2064-89.
3. Wittenauer R, Smith L. Background Paper 6.6 Ischaemic and Haemorrhagic Stroke. Priority Medicines for Europe And the World" A Public Health Approach to Innovation. 2012 Dec.
4. Feigin, V. L., Lawes, C. M. M., Bennett, D. A., and Anderson, C. S. Stroke epidemiology: a review of population-based studies of incidence, prevalence, and case fatality in the late 20th century. Lancet Neurology 2, 43-53. 2003.
5. Feigin VL, Norrving B, Mensah GA. Global Burden of Stroke. Circ Res. 2017;120(3):439–48.
6. Xing C, Arai K, Lo EH, Hommel M. Pathophysiologic cascades in ischemic stroke. International Journal of Stroke. 2012 Jul;7(5):378-85.
7. Tadi P, Lui F. Acute Stroke (Cerebrovascular Accident).
8. Kiran S. What is the nature of poststroke language recovery and reorganization? ISRN neurology. 2012 Dec 23;2012.
9. Zahuranec DB, Skolarus LE, Feng C, Freedman VA, Burke JF. Activity limitations and subjective well-being after stroke. Neurology. 2017;89(9):944–50.
10. Ovbiagele B, Nguyen-Huynh MN. Stroke epidemiology: advancing our understanding of disease mechanism and therapy. Neurotherapeutics. 2011 Jul 1;8(3):319.
11. Feigin VL, Norrving B, George MG, Foltz JL, Roth GA, Mensah GA. Prevention of stroke: a strategic global imperative. Nature Reviews Neurology. 2016 Sep;12(9):501.
12. Schöttke H, Giabbiconi CM. Post-stroke depression and post-stroke anxiety: prevalence and predictors. Int Psychogeriatr 2015; 27:1805□12.
13. Robert Teasell MD, MRehabMed NH. 5.1 The Nature of Cognitive Impairment Post Stroke.
14. Hurford R, Charidimou A, Fox Z, et al. Domain-specific trends in cognitive impairment after acute ischaemic stroke. J Neurol 2013; 260:237–41.
15. Jongbloed L. Prediction of function after stroke: a critical review. Stroke 1986; 17:765-76
16. "Brain Basics: Preventing Stroke". National Institute of Neurological Disorders and Stroke. Archived from the original on 2009-10-08. Retrieved 2009-10-24.
17. Asplund, K., Rajakangas, A., Kuulasmaa, K., Thorvaldsen, P., Bonita, R., Stegmayr, B., Suzuki, K., and Eisenblätter, D. Multinational comparison of diagnostic procedures and management of acute stroke - the WHO MONICA Study. Cerebrovascular Dis 6, 66-74. 1996
18. Fure B. Depression, anxiety and other emotional symptoms after cerebral stroke. Tidsskr Nor Laegeforen 2007;127;1387-9
19. D'Aniello GE, et.al, Characteristics of anxiety and psychological well-being in chronic post stroke patients. J Neurol Sci 2014; 338:191-6
20. De Luca R, Lo Buono V, Leo A, et al. Use of virtual reality in improving poststroke neglect: Promising neuropsychological and neurophysiological findings from a case study. Appl Neuropsychology Adult 2017;1–5.
21. Burdea GC: Virtual rehabilitation—benefits and challenges. Methods Inf Med, 2003, 42: 519–523.
22. Holden MK. Virtual environments for motor rehabilitation: review. CyberPsychol Behav. 2005;8(3):187–211
23. Steuer J: Defining virtual reality: dimensions determining telepresence. J Commun, 1992, 42: 73–93.
24. Keshner EA: Virtual reality and physical rehabilitation: a new toy or a new research and rehabilitation tool? J Neuro engineering Rehabilitation, 2004, 1: 8
25. You SH, Jang SH, Kim YH, et al.: Virtual reality-

induced cortical reorganization and associated locomotor recovery in chronic stroke: an experimenter-blind randomized study. Stroke, 2005, 36: 1166–1171.

26. JOYCE FUNG e.t.al (2006) A Treadmill and Motion Coupled Virtual Reality System for Gait Training Post-Stroke. Journal cyberpsychology & behaviour Volume 9, Number 2, Page no 157-162. 2006
27. Nara Kim e.t.al (2015) Effects of community-based virtual reality treadmill training on balance ability in patients with chronic stroke Journal of Physical therapy Sciences. Volume 27: Page 655–658, 2015.
28. Kang YJ, Ku J, Han K, et al.: Development and clinical trial of virtual reality-based cognitive assessment in people with stroke: preliminary study. Cyberpsychology Behaviour, 2008, 11: 329–339
29. Makssoud HE, Richards CL, Comeau F. Dynamic control of a moving platform using the CAREN system to optimize walking in virtual reality environments. Conf Proc IEEE Eng Med Biol Soc 2009; 2009:2384–7
30. Hyung young Lee e.t.al (2015) Effects of virtual reality-based training and task-oriented training on balance performance in stroke patients. Journal of Physical therapy Sciences. Volume 27: Page 1883–1888, 2015
31. Yang S, Hwang WH, Tsai YC, et al.: Improving balance skills in patients who had stroke through virtual reality treadmill training. Am J Phys Med Rehabilitation, 2011, 90: 969–97
32. Dong Y, Xu J, Chan BP-L, Seet RCS, Venketasubramanian N, Teoh HL, et al. The Montreal cognitive assessment is superior to national institute of neurological disease and stroke-Canadian stroke network 5-minute protocol in predicting vascular cognitive impairment at 1 year. *BMC Neurol.* 2016;16(1):46–46.
33. Cumming TB, Churilov L, Linden T, Bernhardt J. Montreal Cognitive Assessment and Mini-mental State Examination are both valid cognitive tools in stroke. *Acta Neurol Scand.* 2013;128(2):122–129.
34. Martina Maier et.al, Adaptive Conjunctive Cognitive Training (ACCT) in virtual reality for chronic stroke patients A randomised control pilot trail. Journal of Neuroengineering and Rehabilitation. 2020;17
35. Köhler S, Hackett ML, O'Brien JT, et al. Neuropsychiatric outcomes after stroke–authors' reply. Lancet Neurol 2014; 13:1168–9.
36. Hamilton M. A rating scale for depression. J Neurol Neurosurg Psychiatry. 1960;23(56):56–62.
37. Cole JC, Motivala SJ, Dang J, Lucko A, Lang N, Levin MJ, Oxman MN, Irwin MR. Structural validation of the Hamilton Depression Rating Scale. Journal of Psychopathology & Behavioral Assessment. 2004; 26:241–254.
38. Hackett ML, Pickles K. Part I: Frequency of depression after stroke: an updated systematic review and meta-analysis of observational studies. Int J Stroke. 2014;9(8):1017–25.
39. Saltychev M, Lähdesmäki J, Jokinen P, Laimi K. Validity of Total Score of Functional Independence Measure (FIM®) In Stroke Survivors–A Short Communication. PRM+. 2018 Oct 16;1(2):42-4.
40. Ravaud JF, Delcey M, Yelnik A. Construct validity of the functional independence measure (FIM): Questioning the unidimensionality of the scale and the" value" of FIM scores. Scandinavian journal of rehabilitation medicine. 1999 Mar 1;31(1):31- 42.
41. Heruti RJ, Lusky A, Dankner R, et al.: Rehabilitation outcome of elderly patients after a first stroke: effect of cognitive status at admission on the functional outcome. Arch Phys Med Rehabil, 2002, 83: 742–749.
42. Arsic S, Eminovic F, Konstantinovic L, Pavlovic D, Kliajic D, Despotovic M. Correlation between functional independence and quality of executive functions in stroke patients. Turkish Journal of Physical Medicine and Rehabilitation. 2015 Dec 1;61(4):333-8.
43. Tramonti F, Fanciullacci C, Giunti G, et al. Functional status and quality of life of stroke survivors undergoing rehabilitation programmes in a hospital setting. NeuroRehabilitation 2014; 35:1–7