

Virtual Reality Application in Neurological Rehabilitation

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Abstract: In this paper a brief review of virtual reality application in neurological rehabilitation has been presented. A detailed discussion has been made how virtual reality is used to treat patients with neurological disorders. Two different types of virtual reality have been discussed. Virtual reality is a new clinical approach to treat patients by creating a virtual environment for simulation. Based on the study a number of research questions have been framed. Some conclusions have been drawn and future direction of research has been discussed.

Keywords: Neurological rehabilitation, Neuroplasticity, Neuroscience, Tele-rehabilitation, Virtual reality.

I. INTRODUCTION

Virtual reality (VR) is considered as artificial intelligence which creates an artificial 3-dimensional environment for the subject. It involves a computer created incitement by which an individual can interrelate with the artificial environment by means of gloves, goggles or other electronic devices having sensors [1-2]. As compared to the conventional rehabilitation virtual reality can provide better interactive 3D environment for the patients along with the feedback of the intervention performed. Balance and strengthening exercises, gait management and even cognitive assessment can be done efficiently with proper feedback by accommodating the subject with virtual environment [3-4].

The virtual reality as an intervention can bring bodily stimulation to the subject so that the patient can perform the task which they can't even think to attempt otherwise [5-6]. VR includes a force plate which is a type of measuring instrument which is subjected to measure ground reaction forces when subject attempts to move, stand or can perform any other activity, the Wii balance board (force plates) can accurately measure the center of pressure of the patients so that they can be rehabilitated accordingly. Virtual reality is one of the novel approach which provides an artificially synthesized environment for individual to interact and provides a synthetic stimuli for the patient and a well guided virtual ambient so

that patient can experience 3D images and act according to it hence we can say virtual reality is a so called human computer interface which can provide a totally immersive experience for the individuals to interact and can perform multiple strategic operations in context to neurorehabilitation. As VR can provide a realistic perception to the onlooker and can even record the task performed hence has a significant approach in treating patient with neurological impair.

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Virtual reality has proved its potential in many neurological impairments but it not only improves motor impairment but also has a greater impact on cognitive impairment. Several researches have proved the efficacy of virtual reality in improving the mental health, psychosis, depression, anxiety and other mental health related disorder.

As virtual reality provides incorporate response of brain to the external environment as brain uses already stored embodied response in cerebral cortex with reference to the external stimuli the similar way is used by this technique in order to enhance the neuroplasticity to capture new neuronal pathway via different means. It can provide consolidate stimulation which can stimulate sensory neurons for motor functioning that's concerned with cognitive function, memory and emotions and can stimulate multimodal neural network which is concerned with the actions. Concurrence of multi perceptual input into rigorous strategic intervention in order to encapsulate computer generated environment and motor and cognitive functions. Immersive type of VR accompanies large screen projectors or head mounted display system it improves the sensory apparition and hence increase participations of the subject by creating virtual cognitive demand on cerebral cortex. Immersive type of VR implies various interesting task for human computer interface, patients not only become betrothed but also various physical and cognitive demand on cerebral cortex repeatedly enhances neuroplasticity and hence enhances the recovery. The most important component in VR is the multi sensorial modulation in which multiple users can interact with different

angle. The therapy can be so ingenious that patients can always interact with positive attitude towards the goal giving the boost to the rehabilitation VR can offer sensory replica of the environment which is displayed on screen and patient can safely interact with the interface.

Virtual reality is a personage appliance interface which comprises of numerous sensory channels used to provide artificial environment for the patients to perform various task and activity which the patient is unable to attempt due to fear or disability. It not only creates artificial environment for bodily sham but also can provide augmented training to enhance neuroplasticity as an intervention of neurological disorder. Augmented reality provides an interactive environment to the subjects prevailing the intervention, nowadays, several augmented realities is used for several medical assistance such as endoscopy, open surgery, radiosurgery etc. virtual reality or augmented reality is considered as one other futuristic intervention for psychiatric and cognitive rehabilitation.

Virtual reality can also serve the purpose of tele-rehabilitation as the patient can perform task at home under the supervision of a therapist as they have the control over the task of the patient having their bodily simulation with computer interface controlled via remote by the therapist.

VR is not just intervention but it can also assess, measure and have the record of performance done by the patients for futuristic learning and setting of goal for encouraging the patients to get efficiently rehabilitated.

II. VIRTUAL REALITY

Two types of virtual reality are used (i) immersion virtual reality and (ii) non immersion virtual reality

A. Immersion Virtual Reality

Immersion refers to the perception in which subjects perceives that they are present in the artificially made 3D environment. The therapist creates an artificial environment via images and sound as a stimulus for the individual so that these stimuli create demand on patient's neuromuscular junction and cortical neurons enhancing neuroplasticity, the best possible way to treat patient under neurorehabilitation.

B. Non-Immersion Virtual Reality

It involves the technologies used to create human machine interface i.e., the additional equipment such as mouse, projector keyboard etc. It creates artificial intelligence but patient can't presume to be inside the virtual word rather consciously can be the part of it.

III. GENERAL PROCEDURE FOR VIRTUAL REALITY ASSISTED NEUROREHABILITATION

The following procedures are followed for VR assisted neurological rehabilitation:

- Subjects are asked to sit in a comfortable chair and are asked to put their arms resting in prone position on the white table.
- Subjects are made familiar with VR scenario by asking them to wear a head mounted display and are asked to keep their right hand still and are asked to be as relaxed as possible.
- Subjects are asked to observe the virtual hand laying palm down in a white table.
- In an initial trial phase, patients are instructed to move non paretic hand's finger and asked to watch the back projected visual stimuli reflected in the mirror within the VR environment.
- The finger motion is back projected onto a screen showing two virtual hand models.
- A trial is attempted in which the motion of unaffected hand activated on the VR hand, located on the same side or opposite side relative to the actual hand.
- The move prompt is displayed for 5 sec whereas the rest prompt is displayed for 4-7 secs.
- The subjects are instructed to complete the movement within the move phase of 5 seconds.
- Each trial is attempted within the 8 repetition with interrelated virtual feedback and visual feedback of the mirror.

Participants are asked to answer two questionnaires: (i) questions related to the interest in performing task and (ii) questions related to attempts made by patient in order to match VR perceived hand. The VR questionnaires is always performed at the end of entire procedure in order to improve the cognitive functioning and develop interest in neurorehabilitation in a lengthy session.

IV. RESEARCH QUESTIONS

The following research questions are framed from the review of latest literature.

- What is the impact of virtual reality as a convention in treating neurological impairment?
- Is virtual reality having a greater impact over traditional approach in treating cognitive disorders?
- Is it possible to induce visual reminiscence by using non-invasive brain stimulation (NIBS)?
- Whether to choose Virtual reality in treatment of psychosis, depression, anxiety and other mental health disorders over the conventional therapy or not?
- Whether VR as an intervention can be efficiently used as tele-rehabilitation?
- Is this technique can hold good over conventional rehabilitation?

V. SOLUTION FOUND

Tele-rehabilitation opens the gateway of low-cost treatment as they provide distant rehabilitation which involves bodily simulation with computer interface. The subjects can perform task and activity programmed to enhance neuroplasticity in those having neurological impairment. Virtual reality can be the potent intervention to be used in neurorehabilitation to treat both cognitive and motor functioning. VR has advancement over traditional therapy and with larger impact.

VI. CONCLUSIONS

Motor learning is the phenomenon which occurs inside brain in respond to the stimuli (experience or activity performed in external environment) it constructs a neuronal pathway improving motor skill, enhancing the higher order thinking skill and also improves other cognitive & behavioural deficiency. VR can not only have the magnificent effect on neurorehabilitation for motor recovery in neurological impairment but also there is significant recovery in psychological and intellectual functions as VR can provide contemporary functional environment. Patients can deal with artificially made challenging environment which an individual can assess on their own pace with much confidence and with safety measures.

By changing the virtual environment, intellectual functioning of the brain can be altered as by facing embodied simulation repeatedly cognitive modelling of the brain helps in attaining neuroplasticity for the better recovery of mental health related disorder. Moreover, the most important thing which has been observed that an individual finds the session interesting so, the session can be elaborated for more impact in recovery and developing neuroplasticity of brain.

Brain produces incorporate counterfeit for control and co-ordination of body activity similarly virtual reality is also artificially designed to produce embodied sham. The technique to provide a false or deceptive appearance via creating artificial environment helps the person to face the challenging environment helping the ability of brain to reconstruct the lost/delayed cognitive functioning.

VII. SCOPE OF FURTHER STUDY

Further investigation is required to discover the efficiency of tele-rehabilitation in cognitive learning and other behavioural deficit as studies related to it is very less listed. The clinical application is still limited and there is need to work more on

its clinical significance. There is need to investigate bodily simulation effect to enhance neuroplasticity in case of cognitive impairment as there is very little evidence in regard of it.

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