Effects of virtual reality on balance training in pacients with Parkinson's disease: A review study

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Abstract. Parkinson's disease (PD) is a chronic neurodegenerative disease which cause is unknown. The clinical manifestations are related to motor symptoms such as bradykinesia, dystonia, tremor and postural balance disorder, and non-motor symptoms such as cognitive decline and depression. Therapy associated with virtual reality (VR) creates a safe and playful environment to achieve therapeutic objectives. The objective of this review was to evaluate the effects of using VR on balance training of PD patients. This is a bibliographic review study with searches in the Pubmed database, the descriptors used were: Virtual Reality AND Balance AND Multiple Sclerosis. Complete articles in the last five years were included, with a population of individuals with PD, who underwent VR therapy to improve postural balance. In total, 120 results were obtained, and with the application of search filters, 91 articles remained. After reading the titles, 20 studies remained for further reading. Of these, 8 were excluded because they did not meet the eligibility criteria, such as uncompleted study, paid articles or not achieving the review objectives, being included 12 articles for quantitative analysis. Most of them were composed by randomised controlled trial. Of the selected articles, 6 presented exergames as VR technology. The 6 articles left shows other types of VR technology were found in the present study. Such technologies found were: Computer Assisted Rehabilitation Environment (CAREN); Motek C-Mill; V-Gait; NIRVANA. VR training is effective in gaining balance in patients with PD, improving cognitive-motor performance and self-confidence when compared to conventional training alone, thus generating good acceptance by the patient and greater adherence to treatment. It is worth mentioning that it is necessary to assess the patient's level of functionality to implement this type of therapy.

Keywords. Virtual reality, Parkinson, Balance.

1. Introduction

Parkinson's disease (PD) is a chronic neurodegenerative disease which cause is unknown, but several factors appear to play a role, including genects and environmental triggers. Usually, the chances to develop PD increases with age, around 60 or older, and men are more likely to adquire it than women. The pathological changes of the disease are degeneration of cells located in a region of the brain called substantia nigra. These cells produce the substance dopamine, which conducts nerve currents (neurotransmitters) to the body. The clinical manifestations of lack or decrease in dopamine are related to motor symptoms such as bradykinesia, dystonia, tremor and postural balance disorder, and non-motor symptoms such as cognitive decline and depression [1,2,3].

Postural instability and, as a consequence, falls, are among the principal factors that determine the quality of life, as well as the morbidity and mortality of a person with PD. Postural instability increases the risk of falls and, therefore, is correlated with a worsening in the quality of life, morbidity and mortality of a person with PD. Exercise-based therapy causes the nervous system to experience a process called "learning-related structural plasticity", which increases synaptic connections in the brain through various modifications in the anatomical properties of the neural tissue [4].

Among the various rehabilitation approaches that

aim to improve the static and dynamic balance of individuals with PD, therapy associated with virtual reality (VR) has gained ground. This technology creates a safe and playful environment to achieve therapeutic objectives, through generations of computerized images with scenes and objects that simulate real-world environments, by inducing visual, sound and even tactile effects in an immersive or non-immersive way. Therefore, users can easily experience difficult situations in the real world using VR technology, making it a promising tool in balance training [5].

Given the above, the objective of this review was to evaluate the effects of using VR on balance training of PD patients.

2. Research Methods

This is a bibliographic review study with searches in the Pubmed database, the descriptors used were: Virtual Reality AND Balance AND Multiple Sclerosis. Complete articles in the last five years were included, with a population of individuals with PD, who underwent VR therapy to improve postural balance. 3

3. Results and discussion

In total, 120 results were obtained, and with the application of search filters, 91 articles remained. After reading the titles, 20 studies remained for further reading. Of these, 8 were excluded because they did not meet the eligibility criteria, such as uncompleted study, paid articles or not achieving the review objectives, being included 12 articles for quantitative analysis. Most of them were composed by randomised controlled trial.

Of the selected articles, 6 presented exergames as VR technology. When compared to conventional training, the use of this VR category promotes greater self-confidence in carrying out the movements required in games, due to greater competitiveness in overcoming the challenges proposed to advance in levels, helping the patient to overcome their limits and overcome kinesiophobia. Furthermore, involvement with games makes the therapeutic environment more playful, comfortable and fun, increasing the patient's involvement in the treatment and, consequently, bringing better results. Another aspect worth highlighting is the increased ability to process information, improve perception and learn new content, intensifying the cognitive development of people with PD. But it is worth mentioning that it is not recommended for patients with severe levels of postural instability, due to the complexity of movements and independence required in this type of activity.

In one of the studies, that used the Nintendo Wii, it was discussed that VR and motor image (MI) in a combined approach mainly help to normalize the pattern of movement initiation and completion in PD. MI is the imaginary execution of motor activities or the activation of specific muscles when there is an absence of any sort of explicit feedback. These innovative techniques also help patients to modify ineffective movements, being able to perform them in a more functional way that comes from their normal pattern, and to actively avoid them when the need arises [6].

In an article that shows the positive effects of a customised videogame rehabilitation programme, demonstrates positive physiological effects due to the use of VR were observed in a pilot study that used Wii Fit technology, such as increased muscle strength, which was related to increased corticospinal excitability of the leg muscles, with greater emphasis on ankle movements with increased propulsive forces, speed and step length [7].

In another study, this time using the Tymo platform through exergames, it was seen that in addition to the improvement in the functional level, the results show a statistically significant assessment of the psychological sphere: the mental component scale (MCS) of the SF-12 was improved in the experimental group, which carried out the technological intervention. This is because the visual experience extends the treatment beyond imagination techniques, which can accelerate the patient's improvement process. VR is also practical, as there are many phobias, such as movement phobia, which makes the therapeutic experience in that context difficult. Furthermore, it is easier to get the person to move and continue gradually (with few movements until reaching a greater number of movements) and work on the negative feelings that arise throughout this process, thus building confidence. Paloma Oliveto (2018) also mentions the possibility of treating various fears, such as heights and high surfaces.
Therefore, combining exercises and interactive features, the technological intervention provided through the Tymo ® platform appeared to positively influence the psychological well-being of older participants [8].

The 6 articles left shows other types of VR technology were found in the present study, such as the use of platforms with tiltable treadmills, with varying speed and amplitude and an immersive screen, in order to maximize dynamic balance training. Also “sensory rooms” with various sound, visual and even tactile stimuli, which make the experience more immersive and closer to reality. Such technologies found were: Computer Assisted Rehabilitation Environment (CAREN); Motek C-Mill; V-Gait; NIRVANA.

In a study that compares rehabilitation with VR versus conventional training, using the CAREN platform, shows that improvement of dynamic balance contributes significantly to gait. The groups

that received VR training presented better results in gait stability with wider steps and longer single-leg support time [9].

Another study, which uses the NIRVANA technology, that also makes a comparison between VR rehabilitation and conventional rehabilitation, recognised that the rehabilitation of patients with PD is not purely a motor task, but other functions play a crucial role, such as cognition and social interaction. In addition to improving balance and other motor gains, the VR group showed a greater mental aspect of quality of life (MCS) compared with the conventional group [10].

Pullia M, 2023, states that during a virtual reality (VR) rehabilitation session, using the C-Mill technology, the user actively interacts with the digital environment through an avatar or on-screen graphical representation that replicates the user's movements. Consequently, the interaction between motor and cognitive elements can improve neuroplasticity and the acquisition of motor skills more effectively than the mere repetition of motor tasks. In this way, VR-based visual perception of the body induces changes in neural connections that promote integration between the mirror neuron system and the sensorimotor cortex. The importance of mirror neurons lies in their ability to predict both the goal of an action and the potential sequence of steps needed to achieve that goal [11].

Motor learning was significant in the VR groups, whether through exergames or simulation platforms, and is related to the demands of attention, planning, agility and dual-tasking, necessary for success at each level of training, favoring better cognitive-motor performance and functional balance.

According to Cano Porras D, 2017, establishing the appropriate training intensity requires the consideration of at least two factors: progression, which pertains to the level of intensity of the activity, and the patient's drive. This approach aligns with channel flow theory, where achieving the right balance of challenge during a therapy session is crucial to prevent both frustrations, stemming from overly difficult challenges, and boredom, stemming from challenges that are too simple [12].

4. Conclusion

VR training is effective in gaining balance in patients with PD, improving cognitive-motor performance and self-confidence when compared to conventional training alone, thus generating good acceptance by the patient and greater adherence to treatment. Despite the significantly positive results of the previously mentioned studies, there is a need for further research on the subject for better results.

Beyond the physical and cognitive benefits, virtual reality therapy can also serve as a platform for social interaction and emotional support. Patients can connect with others and participate in activities that foster a sense of community, combating the isolation that can accompany this condition. Overall, virtual reality therapy holds great promise in enhancing the holistic care and well-being of individuals living with Parkinson's disease, providing them with a valuable tool to manage their symptoms and improve their overall quality of life.

It is worth mentioning that it is necessary to assess the patient's level of functionality to implement this type of therapy.

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