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Effect of exer gaming on rehabilitation of patient with Parkinson's disease

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Abstract--Parkinson's disease affects the nervous system. It is described as a chronic, progressive condition brought on by a decrease in the number of dopamine neural receptors. Parkinson's disease incidence primarily rises with age, peaking between the ages of 70 and 79, but it stabilises in people in their 80s. Virtual Reality is given to Patients with Parkinson's disease to help alleviate their overall symptoms of illness and improve their quality of life. From the 1960s to the beginning of the 21st century, virtual reality undergoes a four-decade transformation from sensoroma to augmented reality. The objective of the study is to determine the effect of Virtual reality in the rehabilitation of Parkinson's disease. The study design is Quasi-experimental. Diagnosed patients of Parkinson's disease (n=30) up to stage 4 of the Hoehn and Yahr scale were selected by purposive sampling techniques. Then these 30 selected were given to play a game of virtual reality that is Microsoft Kinect for 6 weeks, 4 days a week in Railway General Hospital. Baseline measurement tools were

the Modified Unified Parkinson Disease rating scale, Modified Hoehn and Yahr rating scale and Schwab and England activities of daily life. These measurements were taken before, at the start of the treatment and after, at the end of our treatment (after 6 weeks). Total sample size was 30. The mean age and SD of the study population was 59.97+8.93 years. There was a significant improvement (p-value < 0.05) in the first three parts of MD-UPDRS. Results showed that it not only improved motor functions but also gave a significant improvement in non-motor aspects of daily living. There was a significant (p-value <5) improvement in the staging of modified Hoehn and Yahr disease and Schwab and England activities of daily live scale. Thus, it had been concluded from this research that virtual reality is a treatment of choice to minimize the exaggerated symptoms of Parkinson's disease.

Keywords--exer gaming, kinect, MD-UPDRS, microsoft, Parkinson, Parkinson's disease, virtual reality.

Introduction

Parkinson's is a neuro-degenerative disease. A decrease in the number of dopamine neuro-receptors is thought to be the root of this chronic, progressive illness. [1]. James Parkinson, an English surgeon, published the first accurate description of Parkinson's disease in 1817. Parkinson's was described by him as a trembling palsy. Another renowned French neurologist, Jean-Martin Charcot, developed the notion of Parkinson's disease later in the 18th century and distinguished it from other neurological diseases in which tremor is the primary symptom. [2].

Prevalence

According to a systematic study from 2016, the prevalence of Parkinson's disease in women over 40 is 37.55 per 100,000. Males older than 40 make up 61.21 per 100,000. Parkinson's disease incidence mostly rises with age, peaking between the ages of 70 and 79, but it stabilises in people in their 80s[3]. Europe prevalence is 65.6 to 12,500 cases per 100,000, whereas incidence is 5 to 346 cases. Prevalence in Asia is 15 to 328 per 100,000. Compared to Asian countries, data indicate that Europe has a greater incidence rate of Parkinson's disease. [3, 4].

Pathophysiology

The term "basal ganglia" refers to the collection of firmly set nuclei in the interior region of the brain. Due to their ability to inhibit conflicting movements, the basal ganglia play a crucial part in the smoothness of normal movement. This region of the brain is in charge of initiating motions and facilitating them so that rhythmical and voluntary movements may be performed. [5]. The basal ganglia's substantia nigra, one of the cells that secrete dopamine, is a crucial

neuroreceptor. Parkinson's patients have a decline in dopaminergic cells in the substantia nigra and striatum due to an unidentified underlying reason..[6, 7].

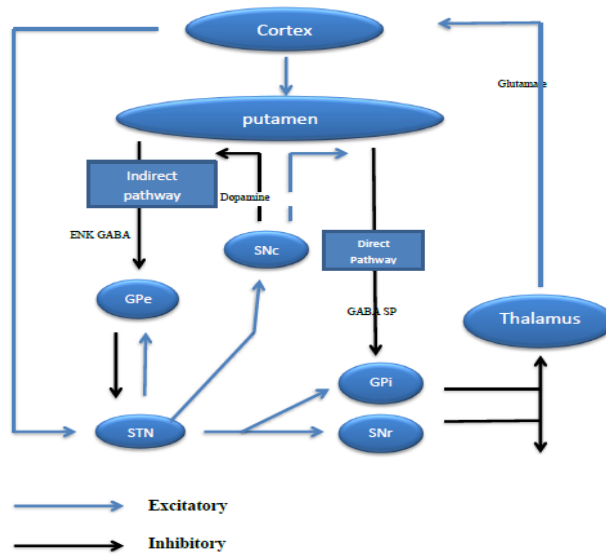


Figure 1: Basal ganglia circuit

Stages of Parkinson’s disease

Parkinson's disease patients do not exhibit any symptoms during the early stages of the illness: braak stages 1 and 2. In this phase, the medulla oblongata and olfactory bulb start to exhibit pathological change. Later, as the illness reaches stages 3 and 4 of the Braak stages, the midbrain and substantia nigra are affected.[1]. Degenerated neurons develop inclusion bodies known as Lewy bodies as the illness progresses. Because they are noticeable in the substantia nigra during the disease, Lewy bodies are a significant indicator of Parkinson's disease. [6]. They are composed of two different sorts of proteins, one of which is called a neurofilament and the other is a type of protein called ubiquitin that breaks down proteins [1].

Table 1
Braak Stages Of PD

Stages of Parkinson’s disease	Involved Structure
Stage I	Nuclei IX and X, Olfactory Bulb
Stage II	Intermediate reticular Zone, Lower Raphe
Stage III	Substantia Nigra, Amygdala, hippocampus
Stage IV	Temporal mesocortex, allocortex
Stage V, VI	High Order sensory association areas of the neocortex and prefrontal cortex

Etiology

Parkinson's disease still has an unknown specific aetiology [8]. Although there is presently no solid evidence to support either viewpoint, it is thought that environmental and genetic variables may both contribute to the development of Parkinson's disease [8]. Recent research has revealed certain genes whose mutation can result in familial Parkinson's disease. . These genes include: 1) Leucine-rich repeat kinase 2) PTEN-induced putative kinase 1, 3) DJ-1, UCHL 1, 4) Parkin, 5) α -synuclein [9]. Others responsible risk factors are summarized in table below.

Table 2
Risk Factors for Parkinson's disease

1. Genes	1. Leucine-rich repeat kinase 2. PTEN-induced putative kinase 1, 3. DJ-1, UCHL 1, 4. Parkin, 5. α -synuclein [8]
2. Bio-Chemicals	Carbon disulfide, cyanide, manganese, and methanol
3. Biohazards	Pesticides
4. Environmental	Well water, farming, wood pulp, industries specifically paper and steel

Sign and Symptoms

There are four primary cardinal symptoms of Parkinson's disease, according to the evidence. These defining characteristics include [8, 9].



Fig 1. Cardinal feature of PD

Some other important and nonmotor symptoms associated with Parkinson's disease are summarized in the figure below.

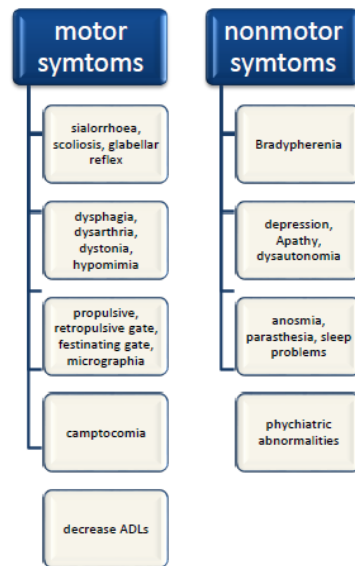


Fig 2. Motor and non-Motor Symptoms of PD

Physiotherapy treatment

Physiotherapy has a very good effect on the freezing of gates, balance and coordination however it has no major difference in cadence, step or stride length. The incidence of falls also decreases after physiotherapy sessions[9]. There is evidence that physiotherapy treatments improve the quality of life for Parkinson's disease sufferers. These sessions involve active or passive mobilisation exercises as well as balance exercises.[9]. The comprehensive study suggested four effective physiotherapy treatment modalities for Parkinson's disease. These modes consist of:

- Strategies for cognitive movement are suggested for the transfer.
- Using both verbal and visual signals to rehabilitate gates.
- Training for joint mobility and physical ability emphasises muscular strength
- Physiotherapy for coordination and balance[9, 10].

Virtual Reality

Virtual reality is also included in the rehabilitation category. Virtual reality, often known as a "virtual environment," is an artificial setting created by a computer in which a person—either a patient or a physical therapist—interacts with this multisensory setting.[11]. Virtual reality may be used in a variety of ways to create virtual environments. It can be either 3D, in which case a full CAVE and 3D glasses are made, or 2D, in which case LED is sufficient to create a virtual world.[12].

Augmented reality

The latest form of virtual reality in which a person interacts within a virtual environment also known as a computer-generated environment. When employing augmented virtual reality, a player feels like they are actually within the game, as opposed to playing from the outside with an avatar. By immersing oneself in that environment, this type of virtual reality was employed to aid fighter jet pilots[13]. Physical therapists benefit greatly from virtual reality in numerous ways. It provides solutions to several problems that rehabilitation teams confront. By incorporating something novel into conventional therapy, it increases the patient's interest.[14]. Physical therapists may assess patients more accurately with the use of a virtual setting, and patients' levels of improvement can be raised by challenging them in a secure digital setting. Other noted flaws include the requirement for a patient to undergo several sessions and repetitions in order to reach functional normalcy because doing so in a hospital setting would not be practical or cost-effective. [15].

Virtual Reality in Parkinson's disease

Virtual reality is beneficial in several ways for Parkinson's patients. Many studies are now being conducted on the rehabilitation of Parkinson's disease and how virtual reality affects it. Parkinson's disease is characterized by a number of different symptoms, one of which is gait disturbance or bradykinesia. This may be avoided by using virtual visual cues, in which man-made impediments can be put in the patient's path and must be navigated by the patient much like the real one. This may be accomplished using light-emitting diodes.[16]. Parkinson's patients can potentially benefit from virtual reality training in transfer. Similar to Hoehn and Yahr Parkinson stages 3 and 4, patients have trouble moving or transferring. The patient's degree of cognitive ability and the games they choose for this purpose determine how dependent this advanced stage is.[17]. Virtual reality significantly extends the quality of life for those with Parkinson's disease. There is evidence that Parkinson's disease enhances both balance and quality of life. Static and dynamic balance are both improved, and the Unified Parkinson's Disease Rating Scale score is also raised (UPDRS) [18]. Virtual reality dance has been shown to enhance melancholy mood and everyday activities in Parkinson's disease patients, similar to dynamic balancing. It has been discovered that virtual reality-based home training is more successful in helping Parkinson's disease patients regain their balance than traditional balancing exercises[19].

Patients who are older than 60 years old are the group most impacted by Parkinson's disease. Patients at this age might not be all that interested in the games or they might become tired quickly. Therefore, physical therapists or trainees should keep these aspects in mind while choosing a virtual reality game, and they should strive to concentrate on basic effective games rather than intricate high difficult ones.[17]. Feedback is essential for piquing patients' attention. Anxiety issues are seen in Parkinson's disease patients. If they are not achieving the objectives of games, they may become quickly distracted or frustrated. Feedback and incentives are therefore crucial for these patients since they not only improve their mood but also inspire them, which may subsequently be shown in their therapy.[20] This study is very significant in treating the patient

with Parkinson's disease. It provides a new chapter in the traditional treatment of PD. Patient's interest has been developed because it gives them challenge in a fun way and motivates them to perform better which not only improves their motor function but also help in concentration and improve their focusing on aim abilities.

Methodology

Study Type

Quasi-experimental study.

Study Setting

The study setting was Railway General Hospital, Rawalpindi, Pakistan.

Sample Size

The sample size was 30 and Patients were selected by a convenient sampling technique to which a virtual reality session was given.

Duration of the study

The duration of this study was 6 months.

Inclusion Criteria and Exclusion Criteria

Inclusion Criteria

- Age between 40 to 80 years
- Either gender
- Hoehn and Yahr Staging of Parkinson's Disease up to Stage 4

Exclusion Criteria

- Hoehn and Yahr staging of Parkinson's disease: stage 5
- Patients with multiple sclerosis, brain tumours, complete brain injuries, strokes, infections, or significant cognitive impairment
- Patients on medications like antidepressants, benzodiazepines or other CNS agents because they interfere with cognitive function
- Patients having epilepsy

Data Collection Procedure

Basic demographics from all the patients who filled the inclusion criteria were taken and then they explained the treatment protocol which is virtual reality. They are asked to play a specific game named Microsoft Kinect Adventure for 15 minutes each day. Patients were asked to relax for 2 minutes after 7 minutes. Breathing exercises were guided to the patients before treatment, between the treatment and after the treatment. Sessions have been given for 4 days a week for

6 weeks. The assessment was taken before and after the 6 weeks through data collection tools.

Data collection tools

- Unified Parkinson's Disease Rating scale
- Schwab and England activities of daily life
- Hoehn and Yahr rating scale

Statistical Analysis

Data was analysed statistically through SPSS 20. Paired t-test was used in our study for analysis and the difference was concluded through mean, standard deviation and p-value. We used a parametric test in our study because our sample size was 30

Results

The total sample size was 30. The mean age and SD of the study population was 59.97+8.93 years (table 3). Of which 29 were male and 1 was female. (Table 4)

Table 3
This table shows the mean+SD of age

Variable	Mean+SD
Age	59.97+8.93

Table 4
It shows the frequency and percentage of genders

Variable (Gender)	Frequency	Percentage
Male	29	96.7
Female	1	3.3

The mean value and standard deviation of pre-Part 1 of the MD-unified Parkinson's disease rating scale were 14.5+6.9 and the mean value and SD of post-Part 1 of the MD-unified Parkinson's disease rating scale was 6.3+5.4. The result showed a Significance (p-value 0.001) difference. (Table 5, Figure 3)

Table 5
MD-unified Parkinson Disease rating scale part 1 pre- and post-treatment.

Variable	Pre-Data Mean + SD	Post Data Mean + SD	P Values
MD-Unified Parkinson Disease rating scale part 1	14.5+6.9	6.3+5.4	0.001

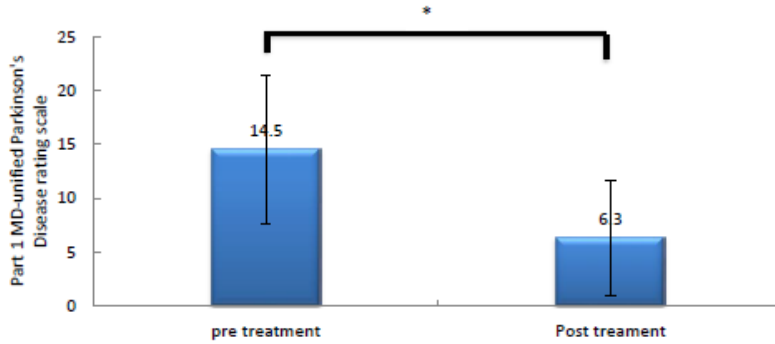


Fig 3. MD-unified Parkinson's disease rating scale part 1 pre- and post-treatment

The mean value and standard deviation of pre-Part 2 of the MD-unified Parkinson's disease rating scale are 14.7+8.6 and the mean value and SD of post-part 2 of the MD-unified Parkinson's disease rating scale is 7.4+7.2. The result shows a significant (P-value 0.001) difference. (Table 6, Figure 4)

Table 6
MD-unified Parkinson's Disease rating scale part 2 pre- and post-treatment.

Variable	Pre-Data Mean + SD	Post Data Mean + SD	P Values
MD-Unified Parkinson Disease rating scale part 2	14.7+8.6	7.4+7.2	0.001

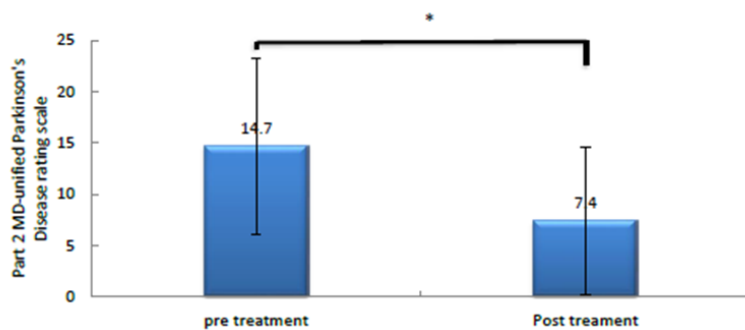


Fig. 4. MD-unified Parkinson's Disease rating scale part 2 pre- and post-treatment

The mean value and standard deviation of pre-Part 3 of the MD-unified Parkinson's Disease rating scale are 28.07+19.71 and the mean value and SD of post-part 2 of the MD-unified Parkinson's disease rating scale is 16.9+16.6. The result shows a significant (P-value 0.001) difference. (Table 7, Figure 5)

Table 7
MD-unified Parkinson's Disease rating scale part 3 pre- and post-treatment

Variable	Pre data Mean + SD	Post data Mean + SD	P value
MD-Unified Parkinson Disease Rating Scale Part 3	28.07+19.71	16.9+16.6	0.001

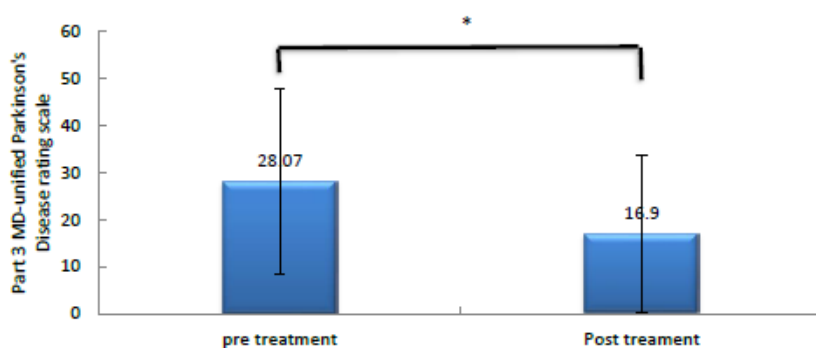


Fig 5. MD-unified Parkinson's Disease rating scale part 3 pre- and post-treatment

The mean value and SD of pre-Modified Hoehn and Yahr rating scale is 3.0+1.2 and the mean value and SD of post Modified Hoehn and Yahr Scale is 1.7+0.9. Results show a significant (P-value 0.001) difference. (Table 8, Figure 6)

Table 8
Hoehn and Yahr rating scale pre- and post-treatment

Variable	Pre data Mean + SD	Post data Mean + SD	P value
Modified Hoehn and Yahr scale	3.0+1.2	1.7+0.9	0.001

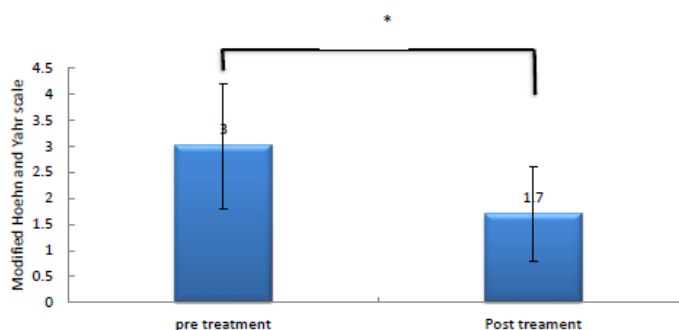


Fig 6. Modified Hoehn and Yahr pre- and post-treatment

The mean value and SD of pre-Schwab and England activities of daily life is 2.0+0.8 and the mean value and SD of post-Schwab and England activities of daily life is 1.0+0.7. The result shows a significant (P-value 0.001) difference. (Table 9, Figure 7)

Table 9
Schwab and England activities of daily life pre- and post-treatment

Variable	Pre data Mean + SD	Post Data Mean + SD	P value
Schwab And England activities of daily life	2.0+0.8	1.0+0.7	0.001

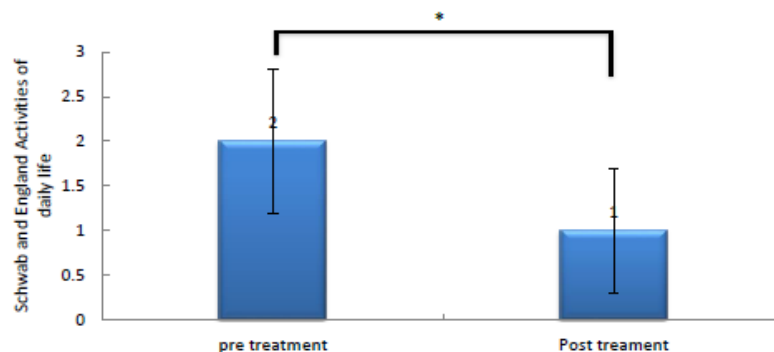


Fig 7. Schwab and England activities of daily life pre- and post-treatment

Discussion

This Study named the effect of Exer gaming on the rehabilitation of patients with Parkinson's disease showed Significant results (p-value <0.05). The mean Age of this study was 59.97+8.93 years. A research that is a systematic review of 127 instances backs that up. They show that the mean age of Parkinson's disease is 61.9 ± 10.7 years [42]. Another randomized control study collected data from 366 patients of which 348 patients were below 70 years with a mean age of 59 years.[21] In this study, 4 patients share blood relations. Various studies show this thing that Parkinson's disease is linked genetically. So, there is evidence of familial links to Parkinson's disease. [22]

In this study, we used the Virtual Reality game Microsoft Kinect 360. Numerous studies have demonstrated its positive impact on Parkinson's disease sufferers. A 2014 pilot trial demonstrates its beneficial advantages, including safety and viability in treating Parkinson's disease. [23]. A 2014 systematic study in the journal of Neuroimaging and Rehabilitation demonstrates that using virtual reality can help Parkinson's patients with their motor symptoms [30]. Another study in Brazil also stated that virtual reality is a good way to treat Parkinson's and improve symptoms[24]. We became aware of the patient's interest in this genre of exercise gaming through the usage of virtual reality. Since they received

their therapy in a setting where other patients might observe them, the patient feels inspired. Patients consider themselves in competition during this type of group activity and challenge themselves to do better and get a higher score than their fellow patients.

The MD-unified Parkinson's disease rating scale is one of the techniques used in this investigation. The majority of research employed an outdated version of the scale, but we preferred the updated version of the unified Parkinson's disease rating scale since we were interested in the specific effects of virtual reality on PD patients. In a Chicago research, neurologist and nurses discovered that the MD-UPDRS provided a more thorough assessment of the symptoms of Parkinson's disease, and it is being utilized in several studies to look at PD[25, 26]. The first part indicated non-motor experience of daily life. The findings of this study demonstrate that virtual reality benefits patients' non-motor functional status in addition to helping them with their motor function. It significantly affects tiredness and depression. The patients in this study discovered a striking difference in their anxiety and mood swings. Another point to make is that daytime drowsiness is significantly lessened in Parkinson's disease patients. Study in Korea also shows a downfall in the depressive state of illness in patients with Parkinson's disease by the use of virtual reality[27]. Exercise is typically thought to have little impact on non-motor symptoms. Contrary to that school of thought, this study gave a positive effect on typical non-motor symptoms. Additionally, patients' motivation levels rise. They accepted the challenge positively and became driven to outperform their other patients in terms of scores. They were able to transcend their incorrect beliefs and boost their energy to cope with issues.

The second part of the tool is associated with motor experience in patients with Parkinson's disease. VR improves the functional limitation including hygiene. It has a good effect on balance with the decrease in the freezing state that most of the patients with Parkinson's have to face. This study's results also support a virtual reality in improving retropulsive and propulsive gates. The study supports our results by stating that it improves the scoring of the second part of the unified Parkinson's disease rating scale[27] This study found no evidence that using virtual reality helped with speech difficulties, salivation, or drooling on this scale. More games that focus primarily on activating face muscles and providing beneficial results in facial expression rehabilitation or providing a remedy for saliva dribbling must be introduced.

The third part indicates a typical motor examination that includes all the motor aspects including tremors, balance coordination, and rigidity. After 6 weeks of intense training in virtual reality, our patients found notable differences in the reduction of their symptoms. Although virtual reality doesn't do much to help with their speech and facial expression issues, it does help them score better overall on the third section of the MD-unified Parkinson's disease assessment scale. Improved rigidity, especially in the lower limbs. With more challenging games, balance and coordination not only grow better but also get better. Particularly purposeful tremor is lessened. Patients who began the research with scores of 1 and 2 in the tremor segment finished with a score of 0. Similar to how some patients struggled with their equilibrium, others had trouble immediately

stopping outside disturbances. But later on, with a progression of study, it is easy for them to handle stimuli that disturb their balance. Another positive effect of virtual reality that has been shown in this study is in a gait abnormality of Parkinson's disease patients. Patients that require assistance initially from some person or walking stick walked independently at the end of the session. Journal of Gerontology in 2010 also shows significant improvement in the third part of the unified Parkinson's disease rating scale by the use of virtual reality [28].

Apart from UPDRS virtual reality also improves the staging of the modified Hoehn and Yahr scale and also the scoring of Schwab and England activities of daily life. Patients who have scoring 1 or 2 on the Hoehn and Yahr scale and 80 or 90 percent in Schwab and England activities of daily life became asymptomatic till the end of the study.

Conclusion

It has been concluded from this research that virtual reality is a very good treatment of choice to minimize the exaggerated symptoms of Parkinson's disease. Virtual reality not only minimizes the motor symptoms of the disease but we also found it good to deal with symptoms other than motors.

Recommendation

We recommend adding virtual reality to a treatment protocol for Parkinson's disease patients. However, further work is needed to require dealing with facial expressions and saliva drooling or speech pathologies. Special virtual games for facial expressions should be introduced. The sample size was small so we recommended doing research with an increased sample for getting better results.

Limitation

- Small sample size
- Short duration of study. Longitudinal studies are needed to be done for detailed monitoring of the effects
- Special games are needed to design for the patients who are at a score of 4 on the Hoehn and Yahr scale. They found it difficult to perform. We don't have such a game available at the time so we excluded those patients from this study that is one of this study's limitation

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