EFFICACY OF SEMI-IMMERSIVE VIRTUAL REALITY ON BALANCE IN FRIEDREICH ATAXIA: A CASE REPORT

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ABSTRACT:

Friedreich Ataxia (FA) is a neurodegenerative disorder caused due to genetic mutation resulting in reduction in messenger’s RNA and frataxin protein levels in body tissues. Semi-immersive Virtual Reality (VR) therapy has been used effectively in the recent times for improving balance and function in neurological conditions. The study is a case of 22-year-old male patient diagnosed with Friedreich Ataxia admitted to outpatient department with balance and gait deficits. The patient was engaged in Semi-immersive virtual reality therapy for 90 minutes a day for a continuous duration of 12 weeks and the training showed remarkable improvement in Rhomberg’s test duration, BBS and ICARS scores. The results suggest that semi-immersive virtual reality therapy appears to be efficacious in improving balance function in Friedreich ataxia.

I. INTRODUCTION:

Friedreich ataxia (FA) is an autosomal recessive disorder, a common inherited ataxia due to unique gene mutation1 which leads to neuro degeneration. Typically, it affects before 20 years of age. Approximately 1 is affected in 50000 population with male and female being equally affected.1 FA which was first described by Nikolaus Friedreich, may have no symptoms at birth or may present with symptoms after the birth until onset of adolescence (mean age is 15.5 year).1,2 It is caused due to expanded guanine adenine adenine (GAA) trinucleotide repeat in the frataxin gene intron on chromosome 9, resulting in reduction of messenger’s RNA and protein levels of frataxin in tissues of body which affects nervous system, cardiovascular system, endocrine system and musculoskeletal system.2,3

Recent advances in technology such as virtual reality (VR) therapy have been used effectively in the rehabilitation medical field and provides the advantage of creating multiple sensory inputs and task-specific approaches by creating a virtual environment that is similar to that of the real world. A study done by CM An and Park YH concluded that semi-immersive VR therapy has a positive effect and can be used as an useful intervention for standing balance and upright mobility function in individuals with chronic incomplete spinal cord injury.4

VR is a type of user– computer interface that implements real-time simulation of an activity or environment and allows user interaction via multiple sensory modalities.5 VR has the advantage of providing real-time performance and graduated stimulus as well as augmenting patients’ attention and motivation.6 So, this case report will give a perspective and relevance for the use of VR in Friedreich’s Ataxia subjects.

II. CASE REPORT:

A 22-year-old male born with consanguineous marriage of parents came with a complaint of difficulty in balancing, fear of fall, difficult in sitting without support, walking and stair climbing since last four years. Since past one year, subject experienced more difficulty in walking and also there is slight difficulty in hearing. There is a relevant family history of his elder brother with same complaints and symptoms had occurred at the same age.
Kyphoscoliosis, pes cavus of right foot, calcaneo-varus deformity of left foot with saddle gap in feet, forward head posture was evident on observation. Examination of the cranial nerves reported positive Rinne and weber's test. Sensory examination revealed reduction in the vibration sense with no loss of proprioception in bilateral lower extremity. Subject had hyperalgesia in bilateral upper extremity. Muscle weakness was evident in bilateral lower limbs with areflexia and extensor plantar response. He also had coordination deficits in bilateral upper and lower limbs. Subject had gait ataxia with positive Romberg’s sign. Subject also presented with high arched palate which may result in a narrow airway and sometimes presented with breathlessness.

Friedreich ataxia mutation analysis concluded that the subject is affected with Friedreich ataxia, reports show the status that expansion of the GAA triplet repeats beyond 250 seen in both alleles of the gene. There was evidence of pure sensory, axonal peripheral neuropathy affecting both upper and lower extremities with presence of H reflex on EMG and NCS studies. MRI of brain revealed mild cerebellar atrophy and spine revealed mild right-sided dorsal lumbar scoliosis with Apex at L1-L2 level. Pre and Post balance assessment was done by 30 seconds Rhomberg test using HUR SMARTBALANCE 2031 with balance software version 2.4.8.0, Berg Balance Scale, International cooperative ataxia rating scale ICARS to determine the level of impairment. (ICC 50.95, Cronbach’s alpha 50.94).

Treatment protocol consisted of semi-immersive virtual reality on stable platform which included games like Tennis, Maze and Stepper which focused on standing balance improvement with Balance Master Platform training along with conventional physiotherapy in the form of strength, flexibility and gait training. Treatment session lasted for 90 minutes per day which was carried out 6 days a week for 12 weeks continuously which included both VR training and conventional therapy. Considerable improvements were reported in Rhomberg’s test duration, BBS and ICARS score post treatment.

Table no. 1: Pre and Post treatment scores of the subject.

<table>
<thead>
<tr>
<th>Outcome measures</th>
<th>Pre-treatment scores</th>
<th>Post treatment scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Romberg’s test (EO)</td>
<td>8 sec</td>
<td>27 sec</td>
</tr>
<tr>
<td>Romberg’s test (EC)</td>
<td>5 sec</td>
<td>21 sec</td>
</tr>
<tr>
<td>BBS</td>
<td>18</td>
<td>40</td>
</tr>
<tr>
<td>ICARS</td>
<td>38</td>
<td>89</td>
</tr>
</tbody>
</table>

![Image 1: Subject performing semi-immersive VR training](image1)
III. DISCUSSION:

The results of the study concluded that semi-immersive virtual reality in FA has definite potential to prove a boon in the rehabilitation of the FA patient. A semi-immersive VR system overlays virtual images onto real images (not avatars) to increase the informative content. Semi-immersive VR allows individualized programs to be provided to individual patients, and immersion is higher than non-immersive VR in that real images are used in the virtual environment. In addition, unlike immersive VR, it has fewer side effects such as “cybersickness.” For this reason, the use of semi-immersive VR systems is recommended in rehabilitation medicine.7,8 Semi-immersive VR therapy has already been proven to be an effective intervention method for balance or walking function in various subjects, such as community-living older adults,9 those with brain tumors10 or traumatic brain injuries,11 and patient’s post-stroke.12

The difference seen in Romberg’s test duration (eyes open & eyes close) along with BBS and ICARS scores of the patient sufficiently suggest that use of virtual reality along with the conventional physiotherapy can aid a better prognosis in balance issues encountered in this autosomal recessive disorder. Although sparse reflection of the improved balance was witnessed in gait of the patient so efficacy of the semi-immersive physiotherapy in improving gait of the patients is yet to be explore. Never the less, more studies are required to explore the positive individual effects of the intervention in FA patient for conclusive evidences. For time being virtual reality can be used as an adjunct to the conventional physiotherapy until a RCT or a systemic review is done to infer its individual effect in prognosis of FA patient.

IV. CONCLUSION:

Semi-immersive virtual reality is effective in balance training in rehabilitation of Friedreich’s ataxia patients.

REFERENCES: