Virtual Reality Training to Improve Upper Limb Motor Function in Multiple Sclerosis: A feasibility Study

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Background

Virtual reality (VR) training presents a motivational and effective out-patient treatment approach with unique tracking and monitoring capabilities for targeted neurorehabilitation, including for PwMS. VR was reported to improve range of motion and muscle strength in PwMS with upper limb function deficits. Since 2016 immersive VR headsets such as Oculus Rift or HTC Vive became available for consumer use and the technology became accessible for medical use via medical VR startups (e.g VRHealth Ltd.)

Immersive VR is considered 4th gen computing system and differs from 3rd gen systems (e.g Kinect) in the ability to fully control and monitor both patient and his environment, providing an ability to generate closed biofeedback loops for rehabilitation. Another unique feature in VR is the ability to provide a true sense of presence and use it to provide strong manipulation that help rehabilitation (e.g. fear of heights training is very effective in VR because of a sense of presence).

In this study we used an Oculus Rift station with touch controllers. This system provides 6 degrees of freedom to move inside a virtual environment and high-end tracking of head and arms movements in an accuracy of 0.01 degrees in 90 Hz. We used two VRHealth applications for motor and cognitive rehabilitation that provide guided motion with different cognitive tasks. All data from training was collected in real-time to a medical server, including raw motion data and event marks from within the game.

Objectives

Evaluate the safety and feasibility of VR motor and cognitive training with an Oculus rift station in PwMS. Collect raw data and questionnaires to assess the quality and relevance of data provided by the platform and to better structure future studies.

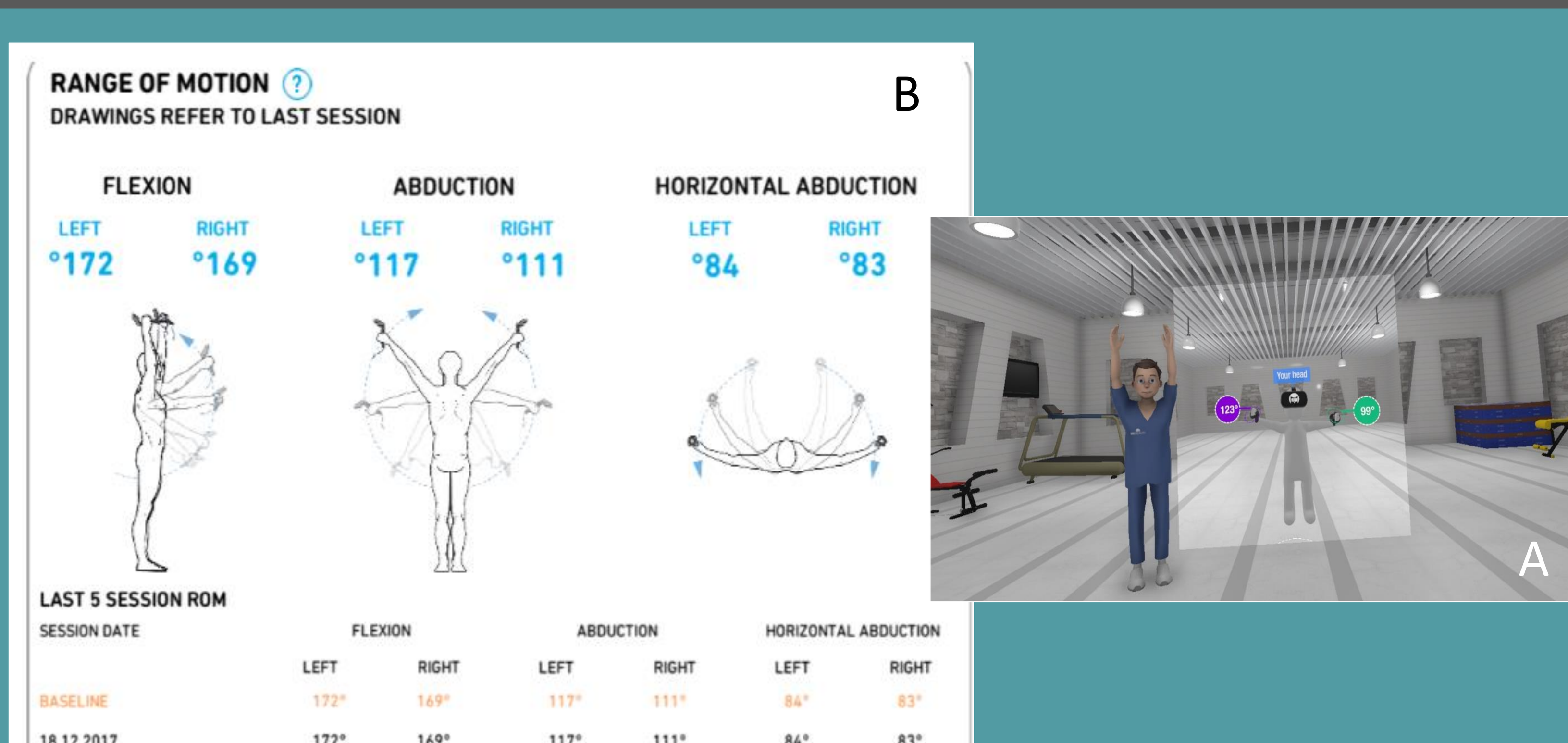

Figure 1: Scenes from VRHealth's ROM (Range Of Motion) test; (A) VR ROM test as performed by a VR user (B) ROM test results.

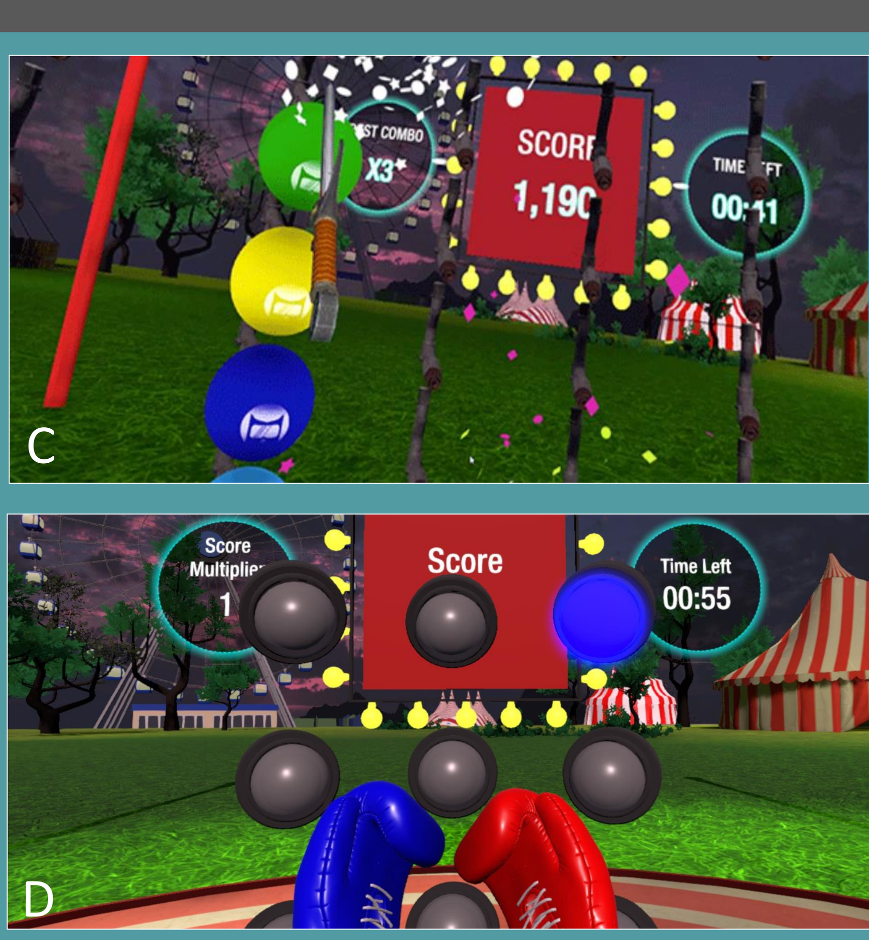

Figure 2: Scenes from VRHealth's applications; (C) *"Balloon Blast"* (D) *"Color Match"*.

Figure 3: The patient wears the head mounted display and holds two hand-held sensors, while a clinician supervises the formance throughout the training.

References

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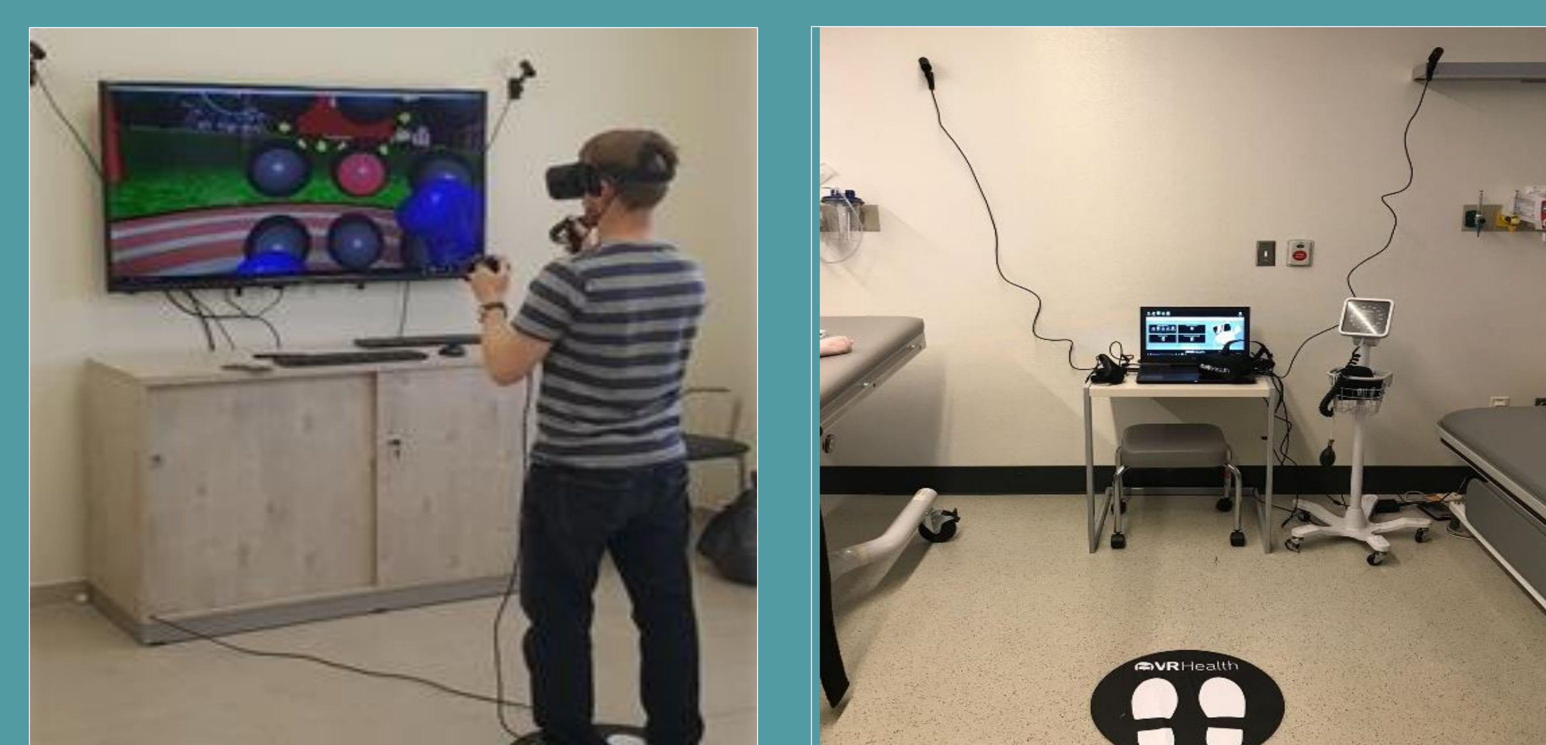

Figure 4: Oculus-Rift platform and station; Positioning of the system's components: Computer, IR sensors, headset and controllers.

Methods

A prospective feasibility study will enroll 30 PwMS with moderate weakness in upper extremity muscles as defined by the British Medical Research Council (BMRC) - grade 4 in two muscle groups, or BMRC grade 3 in one muscle group. A sampling size of 30 patients is a large enough group that should provide a good approximation to the distribution of any intervention-related adverse events (no such cases were noted so far). Patients with visual, cognitive and/or hearing impairments will be excluded.

For the present study, patients will practice two games that require arm and shoulder movements in various directions, including reaching forward towards moving targets. They can practice either standing or sitting, according to their medical condition. They will start with a motor trainer called "Balloon Blast" which is an upper extremity and full body rehabilitation and Active Shoulder ROM Assessment Application. In the game the patient needs to pop a line of balloons with a swipe of a sword, using both hands. The play area is determined by the active ROM measurement. After a short rest they will switch to "Color Match" which is a Motor Cognitive Training and Evaluation Application. In the game they will get two virtual gloves in different colors and they will need to hit color light bulbs with the matching glove. Initial speed and game area will be set to medium level, and dynamic speed will be turned on (speed will go up according to player performance). In both games data will be recorded to provide range of motion, quality of motion, response time, omission and commission mistakes etc. Each upper limb, the strong one and the weak one, will be trained separately. Training will last a total of 30 minutes (Including both games and resting time).

Exercise performance, compensation movements, fatigability and safety of the training will be assessed. Feasibility to perform the VR accurately and any intervention-related adverse events will be recorded. Following the intervention, each participant will complete a questionnaire covering aspects related to the quality of the training and fatigability.

Conclusions

Assessment of VR training in PwMS in this feasibility study will help to design further targeted VR practicing for patients with MS. Farther more, the data collected will help design future studies and better understand the value of VR assessment and training for both patients and caregivers.

Medical VR training and rehabilitation could become a game changing technology for both home training and outpatient rehab. It could provide continuous monitoring of cognitive and motor abilities in MS patients, providing a strong tool for doctors to track and assess their patients and for patients to keep track of their condition.

Figure 5: "*Color Match*" application Session results as presented in the software's summary screen.