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Will Vestibulo-Ocular Reflex and balance rehabilitation reduce visual deficits & improve stability of a patient with Multiple Sclerosis?

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Will Balance and VOR Rehabilitation Decrease Deficits and Improve Stability in a Patient with Multiple Sclerosis?

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INTRODUCTION

MS is a chronic autoimmune neurological disease of the central nervous system (CNS) that affects approx. 2.3 million individuals worldwide.[1,2] Many patients experience episodes of potentially reversible neurological deficits, which are often followed by progressive neurological deterioration. Relapsing-remitting MS is the most common diagnosis affecting about 85% of MS patients, and is characterized by short terms of various symptoms followed by periods of remission.[2] The potential symptoms include but are not limited to: dizziness, vestibular dysfunction, fatigue, instability, decreased strength, and impaired cognition.[3] There is currently no cure for an MS diagnosis, but visual, cognitive, and somatosensory rehabilitation and medications, are being used in an attempt to decrease symptomology and slow down progression.[3]Research has shown the effectiveness of vestibular rehabilitation in reducing dizziness, improving gait, and balance function in post-concussion patients.[4] These patients are comparable to those with MS due to similar CNS and vestibular disruption. Research results suggest Vestibulo-Ocular Reflex (VOR) rehabilitation is beneficial for a patient experiencing vestibular dysfunction and instability.[4] The subject was diagnosed with relapsing-remitting MS in 2003 and experiences visual and balance deficits on his left side. There is limited research on a rehabilitation program combining the effects of both VOR and balance on a single patient with MS.

PURPOSE

The purpose of the study was to create a rehabilitation protocol incorporating VOR and balance exercises to decrease visual deficits and improve stability in a patient with MS. This study will examine the effects of rehabilitation and determine if scores improve from baseline testing.

METHODS

Pre and post-test data were collected using the *VSR ™ sport* and *inVision ™* systems by *NeuroCom*. Testing screen 1.1m from the ground, force plate 1.1m from screen, Participant's eyes 2.13m from the screen for vision exercises. VOR was assessed using *in*Vision™ system to measure: perception time (PTT), static visual acuity, gaze stabilization (GST), and Dynamic Visual Acuity (DVA). The subject wore a calibrated head accelerometer provided by the *in*Vision™ system to measure head velocity. Balance was assessed using VSR™ Sport System to measure: Limits of Stability (LOS) , and Stability Evaluation Test (SET). The subject completed these tests standing on a force plate and high-density foam, provided by the VSR™ Sport system, to measure his center of gravity and sway velocity. The participant completed the baseline tests in the following order: PTT, GST, DVA, SET, and LOS.

The rehabilitation program was divided into three sessions per week: VOR, balance, and a combination of VOR and balance training. The *in*Vision™ system is pre-programmed with levels of difficulty for each background type including: color, stripes, checkers and falling objects. The target head velocity, size of optotype, and metronome pace were manipulated.

The variables changed based on the progress of the patient (Figure1). The rehabilitation protocol progressed appropriately as the patient consistently improved and there were no reported symptoms. The VSR™ Sport System provided the option to choose a sequence training program or a custom training program for the examiner to manipulate. The patient started each category on level three and progressed by weight bearing status, pace time, and surface type (Figure 2).

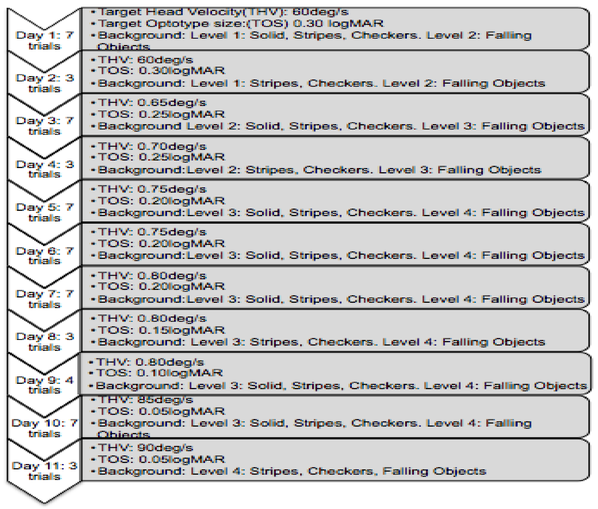


FIGURE 1. VOR Rehabilitation Protocol via NeuroCom® InVision System

FIGURE 2. Balance Rehabilitation Protocol. Core stability exercises along with weight shifts (side to side) were completed twice per week. These exercises lasted for two minutes each, as the rest of the exercises were 1 minute each, or per side. Pacing settings decreased after week 4, which increased the speed at which the subject had to travel between targets. Core stability weight was increased every 3 trials.

RESULTS

The patient had an overall improvement in VOR scores between pre and post-tests (Table 1). From pre to post-test the patient achieved the best possible score of 20ms for PTT. GST had a bilateral increase in achieved average head velocity from pre to post-test with a 44.6% increase on the right from 121 to 175 deg/s and a 60% increase on the left from 98 to 157 deg/s. The patient improved from favoring his right side by 11% to favoring the impaired left side by 5%. PTT, GST, DVA percent changes are highlighted in Table 1. Balance pre and post-test score improvements are highlighted on Table 2. LOS forward reaction time improved from 1.13 seconds to 0.49 seconds. Forward movement velocity improved from 1.9 deg/sec to 4.7 deg/sec and to the right from 2 deg/sec to 6.8 deg/sec. Sway velocity decreased on tandem foam from 10.9 to 4.1 deg/sec. A majority of the scores improved on the stability evaluation test (Figure 3).

TABLE 1. Baseline and Post-Test VOR Scores.

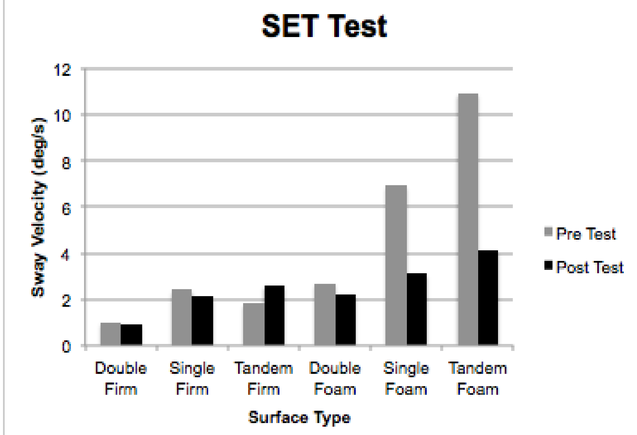
VOR Variable	Baseline	Post-Test	% Change
PTT	30ms	20ms	33%
Static Acuity	-0.28logMAR	-0.30logMAR	7%
GST, Right	121 deg/s	175 deg/s	44.6%
GST, Left	98 deg/s	157 deg/s	60%
Velocity Symmetry	11% R	5% L	54.5%
DVA, Right	0.2 logMAR	0.14 logMAR	30%
DVA, Left	0.3 logMAR	0.06 logMAR	80%

Perception Time Test (PTT), Gaze Stability Test (GST), Dynamic Visual Acuity (DVA)

TABLE 2. Baseline and Post-Test Scores

LOS Variable	Baseline	Post-Test	% Change
Reaction Time, F	1.13 sec	0.49 sec	56%
Reaction Time, B	0.55 sec	0.8 sec	45%
Reaction Time, R	0.64 sec	0.75 sec	17%
Reaction Time, L	0.66 sec	0.76 sec	15%
Mvmt Velocity, F	1.9 deg/s	4.7 deg/s	147%
Mvmt Velocity, B	1.8 deg/s	3.5 deg/s	94%
Mvmt Velocity, R	2 deg/s	6.8 deg/s	240%
Mvmt Velocity, L	2.4 deg/s	4.7 deg/s	96%

Limits of Stability (LOS), Movement (Mvmt), Forwards (F), Backwards (B), Right (R), Left (L)



DISCUSSION

Patients with MS depend strongly on vision for balance control because of proprioceptive and vestibular deficits.[8] This rehabilitation protocol combines VOR and proprioceptive exercises to potentially provide increased stability, coordination within motor functions, and higher quality of life for a patient with MS. VOR is a reflex used to stabilize gaze, which provides a stable environment for retinal focus.[5] As an individual ages, their VOR is increasingly impaired and negatively effects their perception of balance.[5,6] There is no research using the *in*Vision™ system for VOR rehabilitation on patients with MS, but similar symptoms from head induced trauma have decreased from these VOR interactive exercises.[7] According to Cohen, it is necessary to incorporate VOR therapy and rehabilitation programs for patients who are experiencing balance deficits.[8] It is necessary to also train balance in conjunction with VOR, as both of these systems work together during ADLs.[8] The scores of both VOR and balance improved throughout the protocol. Post-test VOR scores have a greater increase from baseline than balance scores. Studies show playing exergames on an unstable surface, such as foam, appears to be an effective way to improve balance and gait in patients with MS. The integration of exergames has a positive effect on adherence and is potentially beneficial for the long-term effectiveness of rehabilitation programs.[9,10] Our results indicate the combination of VOR and balance rehabilitation has a positive effect on a patient with MS experiencing these specific symptoms. Using the systems provided by NeuroCom® is an effective way to maintain the patients adherence and utilize practical balance and VOR exercises. The progression in this protocol was based off of the patient's ability to perform and therefore can vary amongst other patients. Further research should compare the effects of a similar rehabilitation protocol on multiple patients suffering from various symptoms.

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