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Clinical benefits to vestibular rehabilitation in multiple sclerosis. Report of 4 cases

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Abstract

Background: Balance difficulties are common among multiple sclerosis patients. **Objective:** To evaluate the effectiveness of the Cawthorne and Cooksey protocol of vestibular rehabilitation (VR) exercises in reducing the physical, functional and emotional impact of multiple sclerosis among individuals who complained of vertigo. **Methods:** Four patients with remittent-recurrent multiple sclerosis underwent an interview, otorhinolaryngological and vestibular evaluation, VR exercises and the Dizziness Handicap Inventory pre- and post-intervention. **Results:** There was significant improvement in the physical, functional and emotional aspects of the DHI after the completion of the VR. **Conclusion:** The VR exercises appeared useful in reducing subjective complaints of the study participants.

Keywords: vertigo, demyelinating diseases, vestibular diseases.

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INTRODUCTION

Vertigo, imbalance and nystagmus frequently occur in Multiple Sclerosis (MS) cases due to an involvement of regions of the brainstem, spinal cord and optic nerves. Hearing and balance disorders can be early signs of MS due to a close relationship between preferred MS sites and structures that contribute to the maintenance of corporal balance[1].

Vestibular Rehabilitation (VR) exercises have been proposed as treatment for balance disorders. They are based on the mechanisms of neuroplasticity known as adaptation, habituation and substitution and they are used to obtain vestibular compensation[2]. The existing VR protocols when applied can achieve good results. However, there is a lack of studies analyzing the VR exercises results on patients with remittent-recurrent MS (RRMS). The objective of our study was to evaluate the effectiveness of VR exercises in reducing the physical, functional and emotional impact of multiple sclerosis.

METHODS

Participants with complaints of vertigo were selected, regardless the type of vertigo, period of treatment or diagnosis date. After a neurological exam, the exclusion criterions were patients with psychological or oculomotor paresis (or both), internuclear ophthalmoparesis or other severe visual disturbances. We identified 12 patients with the diagnosis of remittent-recurrent multiple sclerosis (RRMS) according to McDonald's[3] criteria, who were interested in participating in the study. Among these 12, only 4 were able to complete it. Their ages ranged between 35-49 years old. Study participants were evaluated at the Otoneurology Laboratory of the Universidade Tuiuti do Paraná. Informed consent was obtained. The study was approved by the local ethics committee.

Patients were interviewed for their medical history and examined by an ENT specialist to rule out other vestibular conditions that might be interfering with the exam. They underwent a vestibular examination (labyrinthine function, ocular tests and electronystagmography) performed by a licensed audiologist.

Patients undertook a special diet, starting 72 hours before the otoneurological exams (abstaining from the intake of coffee, any kind of soda or caffeinated tea, chocolate, smoke, or alcohol). Analgesics, tranquilizers, and antihistaminic and antivertigo medications were suppressed during this period to minimize possible interferences with the test results. Three hours of fasting was recommended prior to the exam.

Vestibular function evaluation is a group of many labyrinthine function and ocular tests. The first part of our patient's evaluation was simply clinical and was based on a systematic search for spontaneous, gaze, and positional nystagmus. The second part was based on interpretation of the ENG test (register the corneoretinal potentials variations using sensitive electrodes) results. The ENG test consists of: calibration of the ocular movements, detection of spontaneous and gaze nystagmus, the oscillatory tracking test, optokinetic nystagmus search, rotatory and caloric tests.

We performed ENG with a three-channel equipment (Berger Eletromedicina, model VN316, made in São Paulo, São Paulo, Brazil). First of all the periorbital region is cleaned with alcohol and after that the electrodes are placed, using electrolytic paste, at the lateral angle of each eye and also in the midpoint of the frontal line. The electrodes are placed on these locations in order to design a triangle that enables the registration of not only horizontal but also vertical and oblique ocular movements.

We performed tests with a rotating chair (Ferrante, model COD 14200, made in São Paulo, São Paulo, Brazil), a visual stimulator (Neurograff Eletromedicina, model EV VEC, São Paulo, São Paulo, Brazil), and an air caloric stimulator (Neurograff Eletromedicina, model NGR 05, São Paulo, São Paulo, Brazil).

Calibration of the ocular and saccadic movements is based on the capture of electric potential variations between the cornea and the retina. We requested patients to keep the head still while visually tracking a light target moving firstly in horizontal direction and then in vertical direction. The equipment is adjusted so that the eye's movement performs an angle of 10 degrees (standard calibration). As these movements are registered, we adjust the gain of the graphic needle to 10-mm of amplitude (first channel) and to 5-mm of amplitude (second and third channels). A variation of 1 degree corresponds to a displacement of 1 mm in the graphic, registered on paper, set under a speed of 5 mm/sec. To ensure the constancy of the distance between both targets and between the patient and the targets, we used the following formula: $x = 2y.\text{tg}5$. The x is the distance between the targets, y is the distance between the patient and the target and tg is a tangent. To evaluate the regularity of the saccadic movements, we used the normal ranges of the following parameters: latency, accuracy, and velocity of movement.

The normal velocity range for spontaneous nystagmus is less than 7 degrees per second with closed eyes. Gaze nystagmus is not expected with open eyes. Occurrence, direction, inhibiting effect of ocular fixation (IEOF), and maximum slow-component velocity of nystagmus were registered.

For the oscillatory tracking test, we requested patients to visually track oscillatory targets in the visual stimulator, and we registered the ocular movements. The type and gain of the ocular movements were observed in the following frequencies: 0.20, 0.40, and 0.80 Hz. The test is used to evaluate the integrity of the oculomotor system in controlling the slow movements of the eyes. The normal standards are nystagmus types I and II.

In the optokinetic nystagmus search, we requested that patients track multiple targets (three horizontal streams of lighted dots) moving forward and backward. The symmetry and gain of the nystagmus were observed. Occurrence, directional preponderance, and measurements of the maximum slow component angular velocity (MSCAV) of nystagmus were evaluated. To calculate the directional preponderance we used the Jongkees formula[4] that is detailed below.

[EQ] DP = [(MSCAVccw – MSCAVcw) / (MSCAVccw + MSCAVcw)] x 100%

where DP = directional preponderance

MSCAVccw = maximum slow-component angular velocity, counterclockwise

MSCAVcw = Maximum slow-component angular velocity, clockwise [/EQ]

Values of less than 20 degrees per second are considered normal for this test.

In the rotation test, the patient's head was tilted 30 degrees laterally to stimulate lateral semicircular ducts (right anterior and left posterior), where the variations of angular acceleration are sensed. After that, the patient's head was positioned 60 degrees backward and 45 degrees to the right and left sides stimulating the vertical semicircular canals. The oscillatory stimulation started at 180 degrees and progressively decreased to 0. We observed the presence, directional preponderance, and frequency of the ocular movements, using the same formula for optokinetic nystagmus search. The normal range for this test is under 33%.

The caloric test requires a tilting of the head and body to 60 degrees backward position (Brunning's position I) for proper stimulation of the lateral semicircular canals[5]. The air stimuli were set at temperatures of 42°C, 18°C, and 10°C, lasting 80 seconds. Records were registered with open and closed eyes to detect IEOF, direction, MSC absolute values, and correlation between directional preponderance and postcaloric nystagmus direction. Normal absolute values are within 2 degrees and 19 degrees per second, whereas normal relative values are lower than 33% for labyrinth preponderance and less than 22% for nystagmus directional preponderance.

We compared the results with normal standards which were obtained from Brazilian population epidemiological studies[6-8]. Table 1 shows the criteria used to analyze each test as well as to distinguish central from peripheral vestibulopathy.

Dizziness Handicap Inventory questionnaire (DHI), Brazilian version

This questionnaire was designed by Jacobson et al.[9] and aims to assess the perception of the disabling effects caused by dizziness. We used the Brazilian version which was translated, validated and culturally adapted to the Brazilian population by Castro[10]. For the translation and cultural adaptation of DHI the internationally accepted steps proposed by Guillemin et al.[11] and used in Europe and America were followed.

The questionnaire was applied by a licensed audiologist before and after completion of the VR exercises. It assessed the level of disability related to dizziness in daily life. The instrument has 25 questions divided in 3 scales: emotional (9 questions), functional (9 questions) and physical (7 questions). The physical scale assesses the relationship between the emergence and/or worsening of dizziness and eye movement, head and body. The emotional scale assesses the impact of dizziness on the quality of life. The functional scale assesses the independence and ability to perform professional activities and everyday life. A "Yes" answer corresponded to a score of 4; "Sometimes" received a score of 2 and "No" received a score of 0. Possible total scores ranged from 0 to 100 points. The extension of disability caused by dizziness in the patient´s daily life will be considered greater if the final score value was near 100. A score of 100 points indicates the maximum damage caused by dizziness; on the other hand, a score of 0 points indicates no injury caused by dizziness in the patient's life. This grading scale applies to each individual.

Vestibular Rehabilitation (VR)

The objective of VR exercises was the improvement of static and dynamic balance function and spatial coordination. The Protocol of Cawthorne and Cooksey[12,13] was selected for its easy administration and because it allowed group sessions. Exercises were administered during a 3-month interval, in 2 30-minute supervised sessions per week. Participants received printed instructions describing exercises on each phase of the therapy. They were asked to do repetitions at home and record the number of times a day they performed each exercise and whether they experienced any symptoms or difficulties.

Patients were informed that they would be working within a level of minimal discomfort, and that the exercises could trigger the symptoms which would activate the natural mechanisms of compensation. The diagnosis of peripheral vestibulopathy is achieved not only by the comparison with normal standards but also by the absence of pathognomonic signs of central vestibular alterations. The observed alterations were predominantly in the peripheral vestibular system. The case reports are detailed below and are followed by Table 2, which summarizes their pre-and post-intervention DHI scores.

CASE 1 - Female, 35, six years of disease, started

Table 1. Normal Standards and Criteria Used to Analyze the Vestibular Tests and Distinguish Central from Peripheral.

	Normal Vestibular Exam	Peripheral Vestibular Exam	Central Vestibular Exam
Position nystagmus (Brandt & Daroff's maneuver)	Absent	Present (rotatory, horizontal rotatory, and oblique) with latency, paroxysm, weariness, and vertigo	Present (vertical inferior, superior, rotatory, horizontal rotatory, and oblique), without latency, paroxysm, weariness, and vertigo
Calibration of the ocular movements	Regular	Regular	Irregular (alterations in latency, accuracy, and velocity of the saccadic movements)
Spontaneous nystagmus	Present (<7 degrees/sec) with closed eyes; absent with open eyes.	Present (>7 degrees/sec) with closed eyes; absent with open eyes.	Present with open eyes (vertical inferior, superior, rotatory, horizontal rotatory, oblique, cyclic, dissociated, and retractor)
Gaze nystagmus	Absent	Absent	Present, unidirectional, bidirectional, or mixed; presents a variety of nystagmus types
Oscillatory track	Types I and II	Type III	Type IV (pathognomonic); alterations of morphology and gain
Optokinetic nystagmus	Symmetrical, <20 degrees/sec	Asymmetrical, >20 degrees/sec, having superposed spontaneous nystagmus with open eyes that justifies this alteration	Asymmetrical, >20 degrees/sec, absent and reduced
Rotation test	>33%, after stimulation of the lateral and superior semicircular ducts	>33%, after stimulation of the lateral and superior semicircular ducts	>33%, after stimulation of the lateral and superior semicircular ducts and absence of induced oblique nystagmus
Air caloric test	Absolute value: between 2 and 19 degrees/sec Relative values: Labyrinth preponderance <33% Nystagmus directional preponderance <22%	Absolute value: <2 degrees/sec (hyporeflexia), >19 degrees/sec (hyperreflexia) and areflexia Relative values: Labyrinth preponderance >33% Nystagmus directional preponderance >22% (Jongkees formula)	Absolute value: <2 degrees/sec (hyporeflexia), >19 degrees/sec (hyperreflexia) and areflexia Relative values: Labyrinth preponderance >33% Nystagmus directional preponderance >22% (Jongkees formula). Different nystagmus types may be observed: dissociated, inverted, perverted, and absence of the fast component of the nystagmus
Inhibiting effect of ocular fixation	Present	Present	Absent

experiencing symptoms of frequent dizziness three years ago, of moderate intensity, associated with headaches, falls, deviation of gait to the right, and sensations of fainting. The vestibular exam revealed a peripheral bilateral deficiency vestibular syndrome.

CASE 2 - Female, 49, two years of disease, started experiencing symptoms of dizziness one year ago, deviation of gait to the right, difficulty and/or pain during movement of the neck, paraesthesia in the extremities and vocal alteration. The vestibular exam revealed a right peripheral vestibular syndrome.

CASE 3 - Female, 43, five years of disease, started experiencing symptoms of dizziness three years ago, deviation of gait to the left, tinnitus, paraesthesia in the extremities, sensation of objects moving around and lack of movement coordination. The vestibular exam revealed a peripheral bilateral irritative vestibular syndrome.

CASE 4 - Female, 38, two years of disease, started experiencing symptoms of dizziness one year ago, sensations of instability, loss of muscular strength in superior and inferior members, imbalance on walking, falls and lack of movement coordination. The vestibular exam revealed a peripheral bilateral irritative vestibular syndrome.

RESULTS

Analyzing the averages obtained before treatment the values showed were: 19.5 on the physical scale, 20.2 on the emotional scale and 18.0 on the functional scale. The averages obtained after treatment were 12.0 on the physical scale, 11.0 on the emotional scale and

Table 2. Pre- and post-intervention Dizziness Handicap Inventory (DHI) scores, by scale and by subject.

Cases	Physical Scale		Functional Scale		Emotional Scale		Total	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	14	8	12	6	11	4	37	18
2	20	10	14	6	24	12	58	28
3	16	8	24	16	28	20	68	44
4	28	22	22	14	18	8	68	44
Mean	19.5	12	18	10.5	20.2	11	57.7	33.5
SD	6.2	6.7	5.9	5.3	7.4	6.8	14.6	12.8

SD - Standard Deviation

10.5 on the functional scale. Therefore, comparing the overall average before (57.7) and after treatment (33.5) we observed a reduction, suggesting an improvement after the application of VR exercises, as shown in Table 2.

DISCUSSION

The observed disorders occurred predominantly in the peripheral vestibular system. Such manifestations are determined by the demyelination plates in the area of the vestibular nuclei in the floor of the IV ventricle[14]. Due to the diffuse nature of the disease, there is an extensive variety of clinical manifestations which are established during recurring sharp or semi-sharp episodes with varying remission[14].

The VR exercises accelerate the physiological process of compensation by means of habituation, generating a conditioned compensatory response of the reticular neurons. These maintain the activation of the cerebral cortex at a homeostatic level by a process similar to the conditioning. Hence, the importance of frequent repetitions[2].

Comparison between pre- and post VR therapy DHI scores showed improvement in the physical, functional and emotional scales. These results corroborate with the studies of Pavan et al.[15]. Cawthorne and Cooksey [12,13] exercises were used by Pavan et al.[15] in cases of vestibular disorders and it was documented that the compensation process can be accelerated.

The improvement of the clinical condition after VR is determined by neural adaptations, sensory substitutions, functional recovery of the vestibulo-ocular (RVO) and vestibulo-spinal (RVE) reflexes, improvements in general physical conditioning, changes in lifestyle and by the positive psychological effect that they exert on the patient with the restoration of physical and psychological security[16].

For Craig et al.[17] the treatment's decision should be based on some points such as lifestyle, physical, functional and emotional aspects, always with the goal of reducing disability and limitations. Frohman et al.[18] demonstrated that benign paroxysmal positional vertigo was the most common cause of vertigo in patients with MS in four years of study.

The patients improved with particles repositioning therapy. Other vertigo was treated with conventional therapies. The authors reported that the use of steroids and labyrinthine suppressants should be administered after careful labyrinth examination.

The present study demonstrated the effectiveness of VR in the treatment of labyrinth dysfunction, decreasing the intensity, frequency and duration of symptoms, improving physical and emotional health of patients and improving the quality of life. An increase in motivation, integration and socialization of the patients was observed as a result of the practice of the exercises in group, revealing that this therapeutic approach can also have implications outside of the hospital.

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