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SUBJECTIVE VESTIBULAR TEST FINDINGS IN INDIVIDUALS WITH MOTION SICKNESS

Medical Science

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ABSTRACT

Introduction: Motion Sickness (MS) is one among the most common distressing ailment accompanied with both actual and perceived motion. Regardless of its commonality, very little is known about the underlying pathophysiology. Several tests have proved the involvement of vestibular system in motion sickness. However, there is dearth of knowledge on the expected findings of Subjective Vestibular Tests (SVT) in individuals with MS. **Aim:** To compare the SVT findings in individuals with and without MS. **Methodology:** Recruited participants were divided into two groups. The group A consisted of participants experiencing symptoms of motion sickness and group B consisted of normal controls. To fulfil the aim of the study, subjects were introduced to SVT such as Romberg's Test, Fukuda Stepping Test (FST), Gait Test, Subjective Visual Vertical (SVV) and Subjective Visual Horizontal (SVH). **Results and Discussion:** The results of the study depicted a good contribution of tests in identifying the affected vestibular system in individuals with MS. Further, about 55% abnormal test findings in eyes open position for SVV test and 50% for SVH test were obtained. Similarly, eyes closed position yielded abnormal test findings of 35% and 20% in FST and Gait test respectively. Finally, upon comparison between the test findings, FST has been situated superior over other SVTs.The recruited tests are known to detect comparatively weaker labyrinth (not necessarily side of lesion) by the observed deviation from the start point in eyes open and closed position. The test results obtained beyond the normative values inherit the presence of otolithic end organ dysfunction in the vestibular system. Therefore, the individuals with MS find it difficult to maintain the expected vertical and horizontal tilt.

KEYWORDS

Motion Sickness, Vestibular System, Subjective Vestibular Tests

INTRODUCTION:

Motion Sickness (MS) is one among the most common distressing ailment accompanied with both actual and perceived motion. It appears as a delinquent in healthy individuals during sea voyage, air/land travel, or an unfamiliar movement. The current development in the field of technology, space travels, and virtual reality activities may contribute towards MS (Bilgen & Kiralzi, 2002). Regardless of its commonality, very little is known about the underlying pathophysiology. One theory postulates a mismatch between the reality and past experiences in vertical motions. However, the theory is not supported by electrophysiological tests.

MS can arise with temporary symptoms such as vomiting, nausea, imbalance, drowsiness, paleness, headache, and cold sweating during the individual's movement or the movement of the visual environment (Yates, Miller, & Lucot, 1998). The younger population have elevated susceptibility to develop MS. Children as young as 6-9 years develop MS which subsides down due to habituation. Likewise, Golding (2006), reported females are on a higher risk of experiencing MS due to hormonal changes.

The vestibular system works in agreement with visual system. Most commonly, the MS occurs in individuals with healthy vestibular systems and visual stimuli which do not work in harmony or due to the presence of highly unexpected or unfamiliar vestibular stimuli (Cheung, Howard, & Money, 1991). The association between the MS and vestibular system is depicted through many studies (Shahal, Nachum, Spitzer, Ben-David, Duchman, Podoshin, et. al.,1999; Shupak, Doweck, 1994). Fowler, Sweet and Steffel (2014), reported higher c-VEMP amplitudes and lower interaural c-VEMP asymmetries in individuals experiencing high susceptibility in developing MS in comparison to individuals with lower susceptibility. Similarly, the findings of another study by Neupane, Gururaj, & Sinha (2018) are in concordance with the above study stating higher c-VEMP asymmetric ratios and affected VOR gain values in vHIT test.

Several tests have proved the involvement of vestibular system in MS. However, there is dearth of knowledge on the expected findings on Subjective Vestibular Tests (SVTs) in individuals with MS. These tests are one of the cheapest tests to be used by a clinician in confirming the involvement of vestibular system in individuals with MS. This study intends to describe the SVT finding of individuals with MS.

METHODOLOGY

The present study aims to compare the SVTs findings in individuals with and without MS.

Participants:

A total of 40 subjects within the age group of 18-29 years participated in the study. The subjects were further grouped into two (Group A & Group B) based on the inclusion and exclusion criteria. The group A consisted of 20 subjects experiencing symptoms of MS and group B consisted of 20 normal controls. Group B was recruited from among the institute staff during the same period and was matched for age to the Group A. Normal controls in Group B did not have any history of middle ear, inner ear, vestibular system or central nervous system pathology or symptoms. A verbal consent was taken from the subjects before recruiting in the study.

Recruited subjects underwent pure-tone audiometry to establish normal hearing thresholds of <15dBHL across frequencies from 250Hz to 8000Hz. This was further followed by administering Immittance Audiometry to check for normal middle ear functioning by obtaining to obtain “A” type tympanogram with present ipsilateral and contralateral acoustic reflexes. Likewise, the subjects also underwent otoacoustic emission test to rule out any outer hair cell dysfunction.

Procedure:

To fulfil the aim of the study, subjects were introduced to various SVTs in a well illuminated room setup. The room was maintained with less distraction and the subjects underwent the following tests:

1. Romberg's test (Rogers, 1980)**:**

The subjects were asked to stand barefoot with feet together and arms held by side in eyes open and closed position. The examiner standing in front assessed the subject for his/her maintenance of posture. Imbalance or sway from the starting point was measured.

2. Fukuda stepping test (FST) (Fukuda, 1959)**:**

The subjects were asked to stand with his/her arms extended at 90 degrees angle with eyes open and closed position. The subject was further asked to march with his/her maximum speed until 50 steps have been achieved. The examiner evaluated the angle of deviation, if any from the start point to identify any presence of vestibular pathology. The cut off for abnormal test findings was selected as 45 degrees.

3. Tandem Gait test (Fregly & Graybiel, 1970):
The subjects were asked to walk forward and backward in a straight line to a marked point in eyes open and closed position. The testing was carried out in a room with relatively less obstacles. Any deviations from the straight line were noted.

4. Subjective Visual Vertical (SVV) and Subjective Visual Horizontal (SVH): (Bohmer & Rickenmann, 1995):
Bucket test technique was utilised. Subject was asked to align the dark line at the bottom of the bucket to his/her best judged vertical and horizontal line. The examiner made a note of any deviations on the protractor placed at the bottom of the bucket from outside. Tilts within 0-3 degrees were considered as normal (Sun, Zuniga, Davalos, Carey, & Agrawal 2014) and any further deviations in the tilt were measured and noted down.

Results and Discussion:
The current study aimed to compare the SVT findings in individuals with and without MS. A total of 40 subjects (Group A and Group B) were subjected to four commonly used SVTs. The subjective tests recruited in the study are known to detect comparatively weaker labyrinth (not necessarily the side of lesion) by the observed deviation from the start point in eyes open and closed position (Honaker, Boismier, Shepard, Shepard, 2009). The results of the study depicted a good contribution of the tests in identifying the affected vestibular system in individuals with MS. The FST, Gait test, SVV test and SVH test depicted higher frequency of abnormal findings with 30%, 15%, 55% and 50% respectively in individual with MS.

Table 1: Represents findings of SVT in individuals with MS

Tests	Degree of deviation	Frequency (%)	
		Group A	Group B
Fukuda Stepping Test	≥45 degrees	30	0
Gait Test	≥45 degrees	15	0
Subjective visual vertical test	4 to ≥10 degrees	55	30
Subjective visual horizontal test	4 to ≥10 degrees	50	20

MS is a result of sensory conflict between the incongruent afferent information from vestibular and visual sensory organs. The disagreement between the information from various sensory channels and the expectations, create the conflicts leading to MS (Bertolini, Straumann, 2016; Lackner, 2014; Schmäl, 2013; Tal, Hershkovitz, Kaminski-Graif, Wiener, Samuel, Shupak, 2013; Yates, et. al., 1998; Reason, 1978). Therefore, the abnormal findings in the individuals with MS depict weaker labyrinths. However, abnormal responses in Group B can be attributed to the specificity of the tests (Brodsky, Cusick, Kenna & Zhou, 2015).

Table 2: Represents the frequency table of SVTs in eyes open and eyes closed position

SVTs	Eyes open		Eyes closed	
	Group A	Group B	Group A	Group B
Romberg Test	0	0	0	0
FST	0	0	35 %	0
Gait Test	0	0	20 %	0

Table 3: Represents the frequency table of abnormal SVV and SVH

Groups	Eye Position	SVV	SVH
Group A	Eyes open	55%	10(50%)
Group B		30%	5(25%)

The head position and body movement in the surroundings is controlled by vision. The information received via vision is imperative for maintaining balance (Berthoz, 2001). Therefore, afferent information from visual sensory organs along with vestibular and proprioceptive cues aid in maintaining balance. The sensory conflict observed between the afferent information via various sensory channels may lead to difficulties for individuals with MS to maintain balance without visual sensory information. The current study compared the test results in eyes open and eyes closed position. The study findings report 55% abnormal test findings in eyes open position for SVV test and 50% for SVH test. Similarly, eyes closed position yielded abnormal test findings of 35% and 20% in FST and Gait test respectively.

Table 4: Represents the SVV and SVH test findings

Degree of deviation	SVV		SVH	
	Group A	Group B	Group A	Group B
0 – 3 degree	45%	70%	50%	80%
4 – 6 degree	20%	20%	35%	20%
7 – 9 degree	30%	5%	10%	0
≥10 degree	5%	5%	5%	0

Overall, the SVV and SVH test depicted higher frequency of abnormal test results in individuals with MS. The SVV test showed 55% and SVH test showed 50 % abnormal test findings with vertical and horizontal tilts of 4 to ≥10 degrees. The otolithic end organ utricle is sensitive to vertical tilt and saccule is most sensitive to horizontal tilt of head. The test results obtained beyond the normative values inherit the presence of otolithic end organ dysfunction in the vestibular system. Therefore, individuals with MS find it difficult to maintain the expected vertical and horizontal tilt (Gray, 2020).

The current study compared the SVT findings in individuals with MS. FST has been situated superior over other subjective vestibular tests. FST showed a statistically significant difference (p-value, 0.043) in eyes closed position. However, unfortunately, the sensitivity and specificity of FST has failed to identify peripheral vestibular dysfunction. Peitersen (1967), Bonanni and Newton (1998) have suggested the use of the FST in combination with other clinical tests (e.g., electronystagmography, rotational chair, head thrust, and head-shaking tests) in the assessment of vestibular pathologies. Therefore, it can be considered as a screening tool for identifying functional asymmetry in chronic subjects however, is still an appreciated tool for patients with acute unilateral vestibular disorders.

The findings of the study are in congruence with the “rule of thumb” model by Stott (1986). The model proposes a set of rules, which if broken will lead to MS: 1. Visual-vestibular: motion of the head in one direction must result in motion of the external visual scene in the opposite direction. 2. Canal-otolith: rotation of the head, other than in the horizontal plane, must be accompanied by appropriate angular change in the direction of the gravity vector. 3. Utricle-saccule: any sustained linear acceleration is due to gravity, and an intensity of 1 g which is defined as “downwards.” Acute peripheral vestibular pathologies like MS often go undiagnosed as our brain is capable of getting adapted and habituated to the given situations. Likewise, habituation is considered as the best remedy for MS and is superior to undertaking anti-MS medications and is free of any side effects (Cowings and Toscano, 2000). Acute symptoms of MS are likely to get habituated with daily physical activities. Nevertheless, if habituation process experiences hurdles, then the MS symptoms may be retained.

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