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## **Exercise Induced Motion Intolerance: Role in Operational Environments**

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### **Summary**

Exercise induced motion intolerance is a newly recognized disorder. This condition has a profound impact on military individuals in operational environments. Individuals present with a variety of symptoms including: headache, nausea, vertigo, and disequilibrium, which occur after exercise. The symptoms generally worsen with time and can significantly impact patients' daily routines since, often, only minimal exertion produces symptoms. We present a cohort of fifteen patients with exercise-induced motion intolerance. We detail the diagnostic work-up in this group of individuals including differentiating this disorder from common motion sickness and other vestibular pathologies. All of the individuals responded to customized vestibular rehabilitation including vigorous physical exertion with head motion. Since this disorder is poorly recognized and responds well to treatment we hope to provide guidelines that will allow practitioners to manage this disorder. Information from this abstract has bearing involving mechanisms and predisposing factors involved in motion sickness for individuals in operational environments and on a variety of military vehicles.

### **Introduction**

Exercise induced intolerance is a recently described balance disorder. There are sparse reports of conditions resembling this disorder in the literature.<sup>1</sup> No prevalence or gender specificity has been identified. The disorder is characterized by nausea and disequilibrium that occur with a change in head position during exercise. Patients will usually demonstrate difficulties performing sit-ups, push-ups, running, and swimming. However, these individuals do not have trouble riding a stationary bicycle.<sup>2</sup> Symptoms can continue or intensify post exercise and may require a cool down period before fully resolving. Patients are often affected by the emotional components of the disorder, which include the sudden onset of this disorder in previously healthy individuals and the subsequent fear of inability to perform occupational tasks in operational environments due to their symptoms. The disorder may be confused with motion sickness. However, these individuals rarely demonstrate classical motion sickness or variants such as Sospite syndrome. The

etiology is poorly understood, but the disorder is an acquired phenomenon. Exercise induced motion intolerance must be distinguished from congenital anatomical inner ear malformations such as patent vestibular aqueduct which causes dizziness with exercise. The condition has military relevance as individuals with this disorder perform poorly in most operational settings and cannot perform physically demanding military tasks. In addition, the physical conditioning training required of active duty individuals cannot be performed if the service member suffers from exercise-induced motion intolerance. Finally, there may be a causal relationship between head trauma and this disorder.<sup>2</sup>

A number of therapeutic modalities have been attempted to control or treat this disorder.<sup>3</sup> Traditional vestibular rehabilitation has been unsuccessful in treating this disorder likely because the therapy fails to stress the system sufficiently. Virtual reality has also been tried but head on body motion was not significant enough in frequency or amplitude to control this disorder. After seeing a number of patients with this disorder in our center, we decided to implement a therapeutic exercise intervention program tailored to the patient's symptoms. The purpose of this study was twofold. The first purpose was to describe the entity of exercise induced motion intolerance. The second purpose was to describe the effects of vestibular physical therapy intervention on subjects with exercise induced motion intolerance. Vestibular physical therapy has been used successfully for patients with complaints of dizziness, imbalance, or other vestibular dysfunctions that are reproduced by movement activities<sup>4-7</sup>

## **Material and Methods**

Fifteen patients presented with symptoms of exercise induced motion intolerance to the Department of Defense Spatial Orientation Center Between May of 1998 and November 2001. Diagnosis was based on history of a patient having symptoms of nausea, disequilibrium, and "dizziness" precipitated by bouts of exercise requiring head motion. There were eight males and seven females with an age range of 21-37 (with the exception of one patient age 60). The mean age was 23.5 years. Forty-seven percent (7/15) had a recent history of mild head trauma secondary to military training. Inquiry about smoking history was made because reports in the literature have suggested that smoking effects vestibular function and dizziness.<sup>8</sup> Individuals underwent a full history, physical, and vestibular test battery. This included a standardized vestibular history and physical exam. Sinusoidal rotational chair testing was performed to assess vestibular ocular reflex gain, phase, and symmetry, and time constant evaluation step-testing (Micromedical Inc, Chatham, Illinois). Computerized dynamic posturography sensory organization test (CDP SOT) (Neurocom, Inc. Portland OR) was utilized to assess vestibular spinal reflex function. In addition, the Dynamic Gait Index (DGI)<sup>9</sup>, the Activity Balance Confidence Scale (ABC),<sup>10</sup> and the Dizziness Handicap Index (DHI)<sup>11</sup> were administered. This battery of vestibular tests was used as an income/outcome measure to assess the results of the rehabilitation program. Time to return to full duty status and regular physical exercise was also documented. We believe that the return to duty tasks and rigorous physical training is the ultimate outcome measure.

Patients underwent a tailored therapeutic exercise intervention developed for each individual with this disorder. Traditional principles of therapeutic exercise were applied to the design of the vestibular rehabilitation regime. Stimuli procedures were selected to provoke vestibular perturbation. Patients performed voluntary and active motion tasks in pain-free available ranges of motion. Appropriate resistance was applied in which the patient performed at maximal tolerated effort. Diagonal and spiral patterns of motion were utilized to simulate functional tasks. External mechanical factors involved in the patient's operational environment such as gravity, acceleration, variable resistance, momentum, and maintaining body position on a fluctuating base of support were considered and included in designing each individuals exercise regimen.

In particular, the therapeutic intervention included a pre-conditioning phase and a therapeutic exercise phase. The pre-conditioning phase was comprised of a walk-jog-run program progressing over five steps from a timed walk followed by a timed jog to a three mile run. The therapeutic exercise phase included an overlay of head motion with the walk-jog-running, spiral and diagonals positional exercises, and exercises on an unstable surface.

## **Results**

The mean time of return to duty for the study group was 4.6-week (range of 2.5-7.5 weeks). Post testing was performed when subjects achieved the functional outcome measure of running three miles asymptotically. Vestibular assessment test means for DHI, ABC, DGI, and CDP SOT pre and post vestibular physical therapy are presented in Figure 1. Statistically significant differences were found for all assessment parameters after vestibular physical therapy intervention ( $p < 0.05$ ). The DHI decreased by a mean of 17.3 points. The ABC scale improved by a mean of 18.5 points after vestibular physical therapy. The DGI increased a mean of 0.8 points. All subjects achieved the maximum possible points (24) on this assessment post therapy. The CDP SOT scores improved from a mean of 67.0 points pre physical therapy intervention to 71.3 post therapy. An example of the sinusoidal rotations chair test results is presented in Figure 2. All patients initially had a phase abnormality at 0.64 Hz on sinusoidal rotational chair testing. Post vestibular physical therapy all subjects returned to normal functional range at 0.64 Hz. This result was statistically significant ( $p < 0.05$ ). The normalization of function was maintained in 11 of the 15 patients. We observed when obtaining patient history that five of our subjects were smokers. It has been suggested that smoking effects vestibular function.<sup>8</sup> Upon review, it was noted that the recurrence rate was significantly higher in smokers. Smokers demonstrated a 60% recurrence (3/5) as compared to non-smokers who demonstrated a 10% recurrence (1/10).

## **Discussion**

Exercise induced motion intolerance appears to be a newly described clinical entity. This group of patients must be distinguished from other forms of dizziness so that the appropriate treatment may be administered. Many of these individuals have suffered mild head trauma prior to the onset of this disorder. The association of head trauma with balance disorders has been reported in the past, but specific links to exercise induced dizziness has not been discussed.<sup>12</sup> The consistent VOR phase abnormality at 0.64 Hz on sinusoidal rotational chair testing appears to represent an increase in velocity storage and results in a visual anticipation during head motion. In these patients the eyes lead the head only when the system is stressed during exercise involving head on neck rotation.<sup>13</sup> This observation is supported by the fact that patients do not experience dizziness when riding a stationary bike. These patients do not respond to traditional vestibular rehabilitation and appear not to demonstrate spontaneous resolution of symptoms. In addition, the appearance of this disorder in otherwise healthy individuals is associated with a significant emotional component. Individuals fear that they may not meet occupational performance standards, or could lose their jobs. Customized vestibular physical therapy intervention with an overlying head motion paradigm resulted in resolution of symptoms in all patients seen at our center. Objective outcomes scores and successful return to work, confirm the patients' reports that they feel better. Unfortunately, smokers face a significantly increased risk of recurrence. Individuals do respond to repeated vestibular physical therapy intervention but have consequentially been on limited duty for an extended period of time. This negative impact of smoking on successful control of vestibular disorders has been reported in the literature at a rate of 44 percent, which is lower than our 60 percent incidence in our exercise induced motion intolerance population.<sup>11</sup>

### **Conclusion**

Exercise induced motion intolerance is a newly described clinical entity which can be diagnosed by history and a small number of objective vestibular physical exam findings. Individuals do respond to the appropriate type of customized vestibular rehabilitation, but do not respond to more traditional rehabilitation techniques. The military nature of our center allows us to see a number of patients with this disorder, and we plan to continue to refine our treatment strategy. We have already begun adding dynamic visual acuity tasking while individuals stand on an unstable surface, and are finding that this may hasten the recovery period. In addition, we are increasing our emphasis on diagonal and spiral patterns of motion that mimic functional activities of daily living and work. The advantage of these techniques is they can be administered in the field and can be tied to the specific operational tasking of the individual.

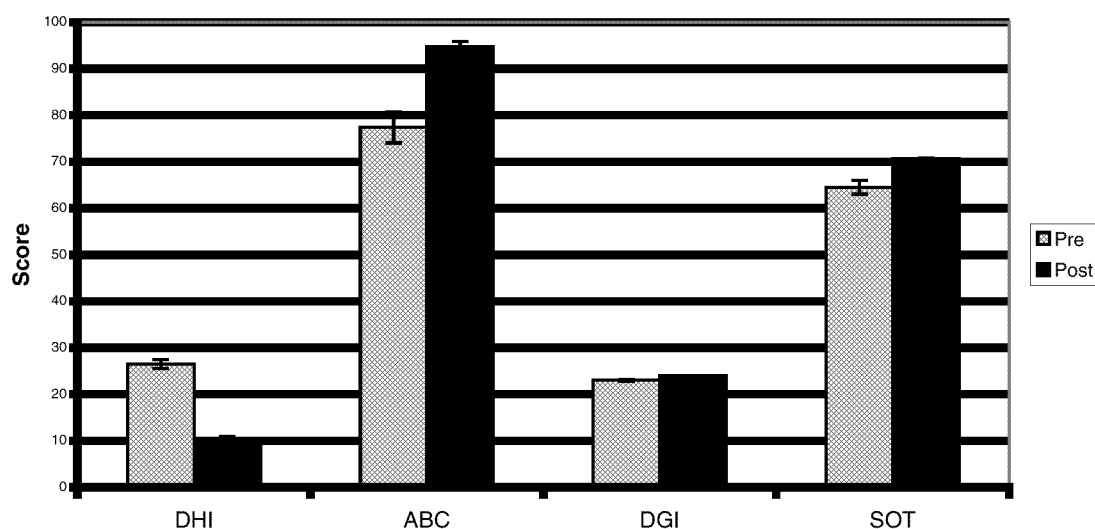
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**Figure 1**

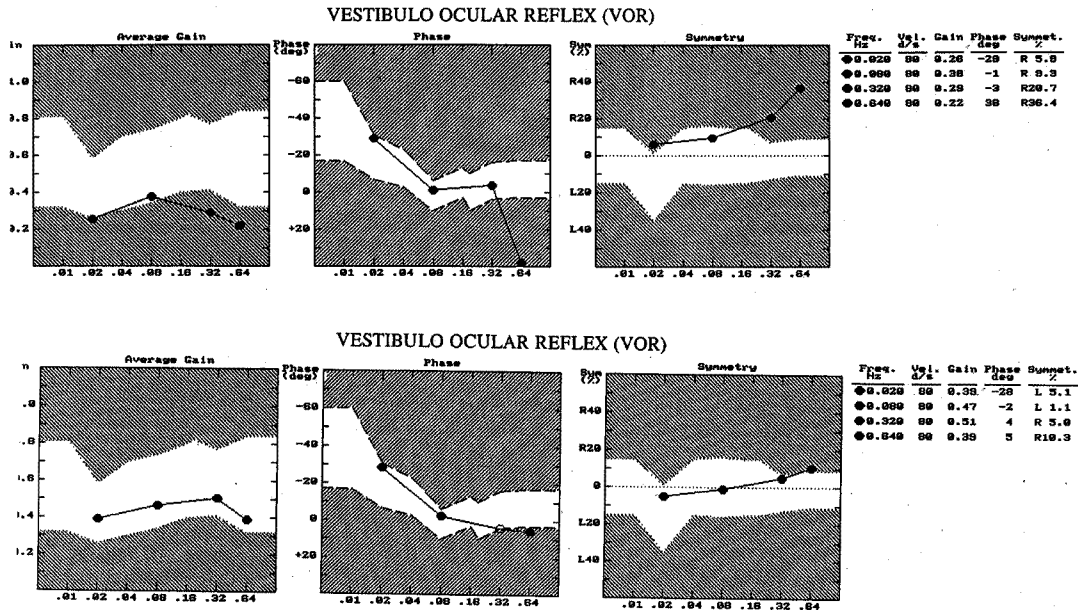
**Outcomes Measures**



Improvement in DHI, ABC, DGI, and SOT after vestibular physical therapy. Hatched bars show pre-therapy measures and solid bars show post-therapy measures. Reduction in DHI indicates improvement whereas improvement in all other measures is denoted by a higher score. Improvement was seen in all four measures and was statistically significant for all four tests.

Figure 2

# VOR Pre- and Post-Treatment



Sinusoidal Harmonic acceleration of VOR gain, phase, and symmetry in one patient from this group. The improvement in VOR phase after vestibular physical therapy was noted in all patients. In addition, this patient had abnormalities in gain and symmetry which improved with therapy, such gain and symmetry abnormalities were not noted in all patients.