Effects of Vestibular Rehabilitation in the Treatment of Dizziness and Balance Disturbances After Concussion

Beth Marschner, DPT, Heather Golly, Ph.D., and Kelsey Higginson, Ph.D.
Minot State University

Abstract

The purpose of this study was to examine the effect of vestibular rehabilitation (VR) versus traditional graduated return to play (TGRTP) concussion treatment protocols on time to return to play, dizziness and balance in athletes. The study utilized a convenience sample consisting of ten athletes from an NCAA Division II University. Participants were randomly assigned to the treatment groups within three days of concussion diagnosis. Pre and post-test consisted of completing the Sport Concussion Assessment Tool (SCAT5), the Dynamic Gait Index (DGI), and visual and vestibular dysfunction evaluation. Data was analyzed using the Mann-Whitney U test to evaluate whether dizziness and balance symptom recovery differed by concussion treatment protocol. The results indicated that there was no significant difference in either treatment group in the time to return to play, however, the 2-tailed test showed initial visual motion sensitivity testing and initial right side Hallpike Dix testing (components of the SCAT5 and vestibular dysfunction evaluation) were significant, p<0.046. Four of the six participants in the VR group reported motion sensitivity symptoms compared to none of the four in the TGRTP group. These two symptoms are associated with dizziness and balance disturbances.

Introduction

Individuals who experience concussions often experience complications including dizziness and balance dysfunctions. Management of dizziness and balance dysfunction is a major challenge after concussion[1]. A concussion is a complex pathological process that affects the brain, induced by biochemical forces[2]. It is a mild form of traumatic brain injury that disrupts normal brain activity[3,4]. The symptoms are usually subtle, such as dizziness and "seeing stars" with the most frequent symptoms being headache, dizziness, nausea and imbalance[3].

The vestibular system is also complex. The inner ear contributes to balance and spatial orientation via the two main components of its sensory system: the two otolith organs, known as the utricle and the saccule and the three semi-circular canals[5]. The semicircular canals and the otolith organs are filled with fluid. The otolith organs are sensitive to gravity and detect linear acceleration of the head while the semi-circular canals detect rotation of the head[6].

The vestibular system also plays a key role in vision. Eye movements coordinate with head movements through visual-vestibular reflexes[7]. The optokinetic reflex allows patients to follow moving objects[8]. The vestibulo-ocular reflex allows the patient to stay focused on an object when the head is moving[7]. If these reflexes are compromised after concussion, disorientation and vertigo are triggered[9].

Severe vertigo can be triggered by concussions when the forces involved cause the tiny calcium crystals, otoconia, in the otolith organs to become dislodged from their normal location and flow freely in the fluid-filled spaces that sense rotation of the head[10]. This may be detected during examination when using the Hallpike-Dix Test[11]. The Epley Maneuver, which involves moving the head into four positions and staying in each position for 30 seconds, is one method designed to reposition those crystals to alleviate vertigo symptoms[11].

Vestibular rehabilitation involves gaze stabilization, habituation, balance training, and exertional training. The exercises are completed multiple times a day to re-establish neural connections to the vestibular system to facilitate vestibular recovery[12]. Gaze stabilization exercises help restore the vestibulo-ocular reflex[13, 14]. Habituation exercises reduce dizziness by exposing the patient to the movement that triggers the symptoms which build a tolerance to the movement[15]. Balance and exertional training reintroduce the patient to daily activity demands both at a skill level and stamina level necessary to return to prior level of function. These are beneficial, and not detrimental, when done voluntarily by the individual[16]. Finding the right balance between rest and activity and between challenge and fatigue is key to success[17].

The use of VR in the treatment of patients after concussion in the presence of dizziness and balance disturbances has been beneficial in case studies[26, 27]. Although the current evidence in systematic reviews is promising in the concussion population, empirical evidence is limited[28]. This study aims to add to the breadth of empirical evidence on the use of VR for concussion. The results of this study may lend credibility to the use of VR in the treatment of patients after concussion.

The purpose of this study was to examine the effect of vestibular rehabilitation (VR) versus traditional graduated return to play (TGRTP) concussion treatment protocols on time to return to play, reducing dizziness and improving balance function in athletes after concussion.

Methodology

Participants

A convenience sample consisting of ten athletes from an NCAA Division II University were referred. Six participants were male while the other four were female. Participants ranged in age from 19 to 21 years of age with an average of 19.6 (SD=0.699) years of age. Participants represented five different sports: baseball, football, women's soccer, track & field, and women's ice hockey. Nine participants were right dominant while one was left dominant. The TGRTP group had four athletes who all experienced a single head impact. Two were males and two were females. One participant in the TGRTP group had never been diagnosed with a concussion before while two had been diagnosed with one concussion before, and one participant had been diagnosed with two concussions previously. The VR group consisted of six athletes. Four athletes experienced a single head impact, and the other two experienced multiple impacts. Four participants in the VR group were males and two were females. Three participants in the VR group had never been diagnosed with a concussion before while two had been diagnosed with one concussion before, and one participant had been diagnosed with two concussions previously.

Methods

Ten athletes were referred from an NCAA Division II University. Participants were referred to the primary researcher after being identified by their certified athletic trainer as having experienced a concussion and were experiencing dizziness and/or balance problems. The initial baseline testing by the researcher was required to be initiated within three days of the concussion diagnosis.

Exclusion criteria included:

- Acute spinal cord injury with neurological deficits
- Epidural and subdural hematoma with known manifestations
- Acute cervical spine injury

Study design: quasi-experimental pretest-posttest research design with random assignment

- Traditional graduated return to play group
- Vestibular rehabilitation treatment group

Measures for pretest and posttest

- Sport Concussion Assessment Tool (SCAT5):
  1. Athlete's background
  2. Symptom evaluation
  3. Cognitive screening
  4. Neurological screening
  5. Delayed recall
- Dynamic Gait Index (DGI)
  1. Gait on level surface
  2. Change in gait speed
  3. Gait with horizontal head turns
  4. Gait with vertical head turns
  5. Gait and pivot turn
  6. Step over obstacle
  7. Step around obstacle
  8. Stairs
- Visual and vestibular dysfunction evaluations
  1. Patient history
  2. Visual assessment
  3. Inner ear assessment
  4. Cervical spine screening

This study design had strong internal validity and allowed the researcher to decide if the vestibular rehabilitation had an effect on time to return to play, dizziness, and balance function according to the SCAT5, DGI, and visual and vestibular dysfunction evaluation data collected.

Procedures

Participants in the study were asked to complete the informed consent form, the SCAT5, the DGI, and vestibular evaluation. Participants then completed the coinciding home programs for the group they were placed in.

TGRTP protocol included symptom management and graduated return to physical activity involving a stepwise progression in which the participant proceeded to the next step if symptom-free at the current step for a 24-hour period. If any symptoms occurred at that step, the participant was returned to the previous step and tried to progress again after 24 hours of rest. The steps were as follows:

1. Patient to return to regular activities such as school
2. Light aerobic activity to increase the patient's heart rate achieved with 5 to 10 minutes on a stationary bike or walking but without weightlifting
3. Moderate activity which increased the heart rate with head or body movement that may have included sport specific exercise with minimal-moderate resistance
4. Heavy, non-contact activity in three planes of movement
5. Full contact practice
6. Competition

VR techniques included gaze stabilization, habituation, balance training and exertional training. Exercises utilized included visual tracking, gaze holding with head turns, saccades, visual accommodation exercises, visual convergence exercises, positional accommodation, rockerboard proprioception, single leg balance on the floor and on dynamic surfaces, tandem balance on the floor and on dynamic surfaces, double leg balance on dynamic surfaces, mirror feedback of functional activities, and physical exertion training with walking, biking or sport specific activities.

The initial session was an hour in duration with two follow-up sessions per week for up to four weeks under the supervision of the primary researcher who was a licensed physical therapist and licensed and certified athletic trainer. The follow-up sessions varied in length between 30 and 60 minutes depending on the goals of each session and the participant's responses. The participant was able to complete the study sooner than four weeks if all symptoms had resolved and return to full, unrestricted play and competition was achieved. At the end of the subject's participation, measures were retested for data comparison.

Results

Data Analysis

Statistical analysis was conducted using SPSS software. The Mann-Whitney U was the recommended statistical analysis for the design in this study and the small number of participants. The level of significance is being reported with the findings.

The results showed no significant difference in either treatment group in the time to return to play or in sign or symptom recovery because all participants reached the same recovery goals.

However, the 2-tailed test showed initial visual motion sensitivity testing (component of the SCAT5) and initial right side Hallpike Dix testing (component of the vestibular dysfunction evaluation) that were significant, p<0.046. Four of the six participants in the VR group reported motion sensitivity symptoms compared to none of the four in the TGRTP group. These two symptoms are associated with dizziness and balance disturbances.

	N	Minimum	Maximum	Mean	Std. Deviation
Traditional Graduated Return to Play Group time to return to play	4	10	21	14.5	5.06623
Vestibular Rehabilitation Group time to return to play	6	8	18	13.1667	3.4302

Table 1: Compares traditional graduated return to play (TGRTP) group to the vestibular rehabilitation (VR) group for the number of participants, minimum days, maximum days, mean days for return to play and standard deviation

	Time to Return to Play
Mann-Whitney U	10.500
Wilcoxon W	31.500
Asymp. Sig. (2-tailed)	0.748
Exact Sig. [2*(1-tailed Sig.)]	0.762

Table 2: Demonstrates that the statistical analysis using the Mann-Whitney U showing that there was no significant difference in the groups with their time to return to play

	Initial Visual Motion Sensitivity Test	Initial Dix-Hallpike Right
Mann-Whitney U	4.000	4.000
Wilcoxon W	14.000	14.000
Asymp. Sig. (2-tailed)	0.046	0.046
Exact Sig. [2*(1-tailed Sig.)]	0.114	0.114

Table 3: Demonstrates that the statistical analysis using the Mann-Whitney U presents significant difference between the groups for the initial presentation of symptoms: Initial Visual Motion Sensitivity Test and Initial Dix-Hallpike Right.

Conclusion

Although the results indicated that there was no significant difference between the treatment groups in the time to return to play or in sign or symptom recovery, this should be interpreted cautiously because the 2-tailed test showed initial visual motion sensitivity testing (component of the SCAT5) and initial right side Hallpike Dix testing (component of the vestibular dysfunction evaluation) were significant, p<0.046 meaning that the two groups were not equivalent in symptom severity. Four of the six participants (67%) in the VR group reported motion sensitivity symptoms, associated with dizziness and balance, compared to zero (0%) of the four in the TGRTP group during the pretest measures. These symptoms were only found in the VR group; which although the treatment outcomes were not statistically significant between the two groups, the participants demonstrating worse dizziness and balance symptoms did show clinical improvement at the same rate and amount as the TGRTP group. Therefore, the comparison should be used cautiously because the treatment groups were not equivalent at baseline. Potentially this could mean that VR is more effective in treating concussions with dizziness and balance symptoms; more research is needed to determine the efficacy of the two treatment protocols with larger participant numbers.

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