Vestibular Rehabilitation for Dizziness and Imbalance Following Concussion: A Critically Appraised Topic

Ian McGinnis, BS, LAT, ATC, Justin Cobb, BS, LAT, ATC, Ryan Tierney, PhD, LAT, ATC,
and Anne Russ, PhD, LAT, ATC
Temple University

Clinical Question: What is the efficacy of vestibular rehabilitation for treating imbalance and self-reported dizziness in patients experiencing prolonged symptoms of concussion? **Clinical Bottom Line:** There is consistent, but low-level, evidence supporting that vestibular rehabilitation can have a positive effect on self-reported dizziness (dizziness severity, Dizziness Handicap Inventory [DHI], Activities-Specific Balance Confidence Scale [ABC]) and objective balance (Sensory Organization Test [SOT], Balance Error Scoring System [BESS]) in patients with prolonged symptoms following concussion. Vestibular rehabilitation is not for every concussed patient. Several, though few, patients did not improve or became worse with the implementation of vestibular rehabilitation. Many of the vestibular rehabilitation exercises utilized in these studies are easily accessible to athletic trainers and, with informed decision making and proper oversight, could be implemented in the athletic training room.

Keywords: evidence-based, mTBI, recovery

Introduction/Clinical Scenario

Dizziness and imbalance are two of the most commonly-reported symptoms in the early stages of concussion. Anywhere from 23–81% of patients report dizziness in the days following injury.^{1–3} An initial presentation of dizziness can be a predictor of prolonged recovery from concussion, both in athletic and general populations.^{4–6} The vestibular system's regulation of balance, spatial orientation, and gaze stability plays a key role in athletic tasks and many activities of daily living. Disruption of the vestibular system can exacerbate other symptoms of concussion and prolong recovery further. Initial clinical findings of dizziness and imbalance through subjective means or objective testing require further investigation and initiation of appropriate management strategies.⁴ Assessment of vestibular/ocular function and sensory integration can include smooth pursuits, saccadic eye movements, near-point convergence testing, vestibulo-ocular reflex testing, visual motion sensitivity testing, the Balance Error Scoring System (BESS) test, and the Sensory Organization Test (SOT).⁷

Most individuals who experience a sport-related concussion will clinically recover within 1 month.⁸ For dizziness and imbalance caused by concussion that do not resolve spontaneously within this time frame, vestibular rehabilitation is thought to bring about symptom resolution. The cause of these symptoms must be determined as either central or peripheral. Central causes include diffuse mild brain injury while peripheral causes involve damage to specific vestibular structures including the semi-circular canals and macular organs. These two sources of dizziness and imbalance require distinctly different courses of treatment.⁴ Those with central causes will most likely benefit more from vestibular rehabilitation while those with peripheral causes require further investigation and will likely benefit from a combination of specific

interventions like a canalith repositioning maneuver and vestibular rehabilitation.

Therapeutic exercise prescription for vestibular rehabilitation is individualized based upon the patient's dizziness profile and functional challenges.^{1,3,9} Common exercise types and their modifiers are described by Alsalaheen et al.³ The development of advanced technology has enabled some clinicians to create virtual-reality environments to immerse their patients in situations that are congruent to their athletic or work setting.⁹ Vestibular ocular exercises as a whole and all of their modifications challenge the vestibulo-ocular, vestibulospinal, and vestibulocollic reflexes.⁴ Outpatient sessions are typically supplemented by home exercise programs that are performed daily. Due to a lack of consistency in exercise prescription and administration, it is difficult to make meaningful assertions about the effect of vestibular rehabilitation on resolving dizziness and imbalance.

Focused Clinical Question

What is the efficacy of vestibular rehabilitation for treating imbalance and self-reported dizziness in patients experiencing prolonged symptoms of concussion?

Search Strategy

A search of PubMed and SPORTDiscus was conducted in February of 2017 using the following PIO (patient group, intervention, outcome) setup as a means to generate a Boolean phrase. Boolean phrase: vestib* AND rehab* AND (concussion OR "mild traumatic brain injury" OR mTBI OR traumatic brain injury" or TBI) AND dizziness AND balance.

- Patient group: Concussed patients experiencing prolonged dizziness and imbalance
- Intervention: Vestibular rehabilitation

McGinnis, Cobb, Tierney, and Russ are with the Department of Kinesiology, Temple University, Philadelphia, PA. Russ (anne.russ@temple.edu) is corresponding author.

Table 1 Description of Outcome Measures

Outcome Measure	Scoring	Assessing
Dizziness severity	Patients asked to rate their perceived dizziness on a 100-point scale; range = 0–100 (best–worst)	Self-reported dizziness
Activities-specific Balance Confidence Scale (ABC)	16 items rated from 0–100; average is taken for the total score; range = 0–100 (worst–best)	Self-reported impairment caused by dizziness
Dizziness Handicap Inventory (DHI)	25 items scored on three response levels (yes = 4, sometimes = 2, no = 0); range = 0–100 (best–worst)	Self-reported impairment caused by dizziness
Sensory Organization Test (SOT) composite score	Six conditions scored with the average taken as the composite; range = 0–100 (worst–best)	Postural stability, postural sway, sensory organization
Balance Error Scoring System (BESS)	Six items with a maximal score of 10 per item; range = 0–60 (best–worst)	Postural stability and sensory integration

- **Outcome:** Subjective and objective measures of dizziness and balance (Table 1)

Inclusion criteria were:

- Studies that used pre- and posttreatment measures
- Studies that used vestibular rehabilitation as therapy
- Outcome measures that were representative of dizziness and balance
- Studies performed within the past 10 years
- Studies published in English

Exclusion criteria were:

- Studies that used aerobic exercise as therapy
- Studies that used cervical rehabilitation as therapy

Evidence Quality Assessment

Internal and external validity of the selected studies were assessed using the STROBE checklist for cohort studies^{1,10} and the Center for Evidence Based Management (CEBM) critical appraisal of a case study⁹ forms. For each selected study, two researchers independently scored the forms and the averages were used for strength of recommendation.

Results of Search

Summary of Search, Evidence Appraised, and Key Findings

In total, our search yielded 109 records (72 from PubMed, 37 from SPORTDiscus). A summary of search results can be seen in Figure 1. Each article included utilized a test retest^{1,10} cohort or case study design.⁹ The articles included in Table 2 met all inclusion criteria and were selected for inclusion in this CAT. Most, but not all, patients improved in every outcome measure of interest—dizziness severity, Dizziness Handicap Inventory (DHI), Activities-Specific Balance Confidence (ABC) scale, SOT, and the BESS test—after completing vestibular rehabilitation.

Results of Evidence Assessment

Two^{1,10} of the studies were assessed using the STROBE checklist. The Alsalaheen et al.¹⁰ study received a score of 20/22 and the Kleffelaar et al.¹ study received a score of 16.5/22. The third study⁹ was assessed using the CEBM critical appraisal of a case study form and scored an 8/10.

Figure 1 — Summary of search results.

Clinical Bottom Line

There is consistent, but low-level, evidence supporting that vestibular rehabilitation can have a positive effect on self-reported dizziness (dizziness severity, DHI, ABC) and objective balance (SOT, BESS) on patients with prolonged symptoms following concussion. However, vestibular rehabilitation is not for every concussed patient. Several, though few, patients did not improve or became worse with the implementation of vestibular rehabilitation. Lack of improvement in certain patients may be attributable to cervicogenic symptoms or benign paroxysmal positional vertigo (BPPV) that were not addressed in rehabilitation. Many of the vestibular rehabilitation exercises utilized in these studies are easily accessible to athletic trainers and, with informed decision making and proper oversight, could be implemented in the athletic training room.

Strength of Recommendation

Results from the involved studies consistently indicate the utility of vestibular rehabilitation. However, the relatively low-level quality of the studies—retrospective cohort,¹⁰ case series,¹ and case study⁹—limit the strength of recommendation. We thereby assign a Strength of Recommendation Taxonomy rating of B.

Table 2 Characteristics of Included Studies

Characteristics	Study		
	Alsalaheen et al. ¹⁰	Kleffelgaard et al. ¹	Gottshall & Sessoms ⁹
Study title	Vestibular rehabilitation for dizziness and balance disorders after concussion	Vestibular rehabilitation after traumatic brain injury: case series	Improvements in dizziness and imbalance results from using a multi-disciplinary and multi-sensory approach to vestibular physical therapy - a case study
Study participants	114 patients: Adults = 25 women, 22 men; mean age 41 (range = 19–73) Children = 45 girls, 22 boys; mean age 16 (range = 8–18) Median time from injury to referral = 61 days (range = 6–2,566)	4 patients: 2 men, 2 women Mean age = 36 Mean time from injury to initial encounter = 16.75 months	1 patient: Male active duty service member Age = 41 Began physical therapy 22 days postinjury
Inclusion/ exclusion criteria	Patients experiencing prolonged dizziness symptoms referred to a tertiary balance center for vestibular rehabilitation following diagnosis of a concussion	Inclusion: TBI aged between 16 and 60 years; dizziness reported on Rivermead Postconcussion Symptoms Questionnaire; positive Romberg test Exclusion: Severe psychological disease; language problems; cognitive dysfunction; fractures/other comorbidities affecting mobility	N/A
Outcome measures	Collected: Dizziness severity scale, range = 0–100 (best-worst); ABC Scale, range = 0–100 (worst-best); DHI, range = 0–100 (best-worst); SOT, range 0–100 (worst-best) Measured: Pretreatment, posttreatment	Collected: DHI, range = 0–100 (best-worst); BESS, range = 0–60 (best-worst) Measured: Pretreatment, posttreatment	Collected: DHI, range = 0–100 (best-worst); ABC Scale, range = 0–100 (worst-best); SOT, range 0–100 (worst-best) Measured: Pretreatment, posttreatment
Results	Dizziness severity (n = 64) Pretreatment mean = 21 (95% CI = 15.5, 26.5) Posttreatment mean = 12 (95% CI = 7.5, 16.5) Effect size = 0.45 ABC (n = 68) Pretreatment mean = 64 (95% CI = 57.4, 70.5) Posttreatment mean = 84 (95% CI = 79.9, 88.1) Effect size = 0.89 DHI (n = 69) Pretreatment mean = 49 (95% CI = 43.9, 54) Posttreatment mean = 30 (95% CI = 24.7, 35.3) Effect size = 0.88 SOT (n = 22) Pretreatment mean = 48 (95% CI = 39.9, 56.1) Posttreatment mean = 71 (95% CI = 65.4, 76.5) Effect size = 1.41	DHI (n = 4) Pretreatment mean = 56.5 (95% CI = 44.2, 68.7) Posttreatment mean = 32 (95% CI = 8.8, 55.2) Effect size = 1.31 BESS (n = 4) Pretreatment mean = 31.5 (95% CI = 29.1, 33.9) Posttreatment mean = 16.5 (95% CI = 10.5, 22.9) Effect size = 3.09	DHI (n = 1) Pretreatment = 18 Posttreatment = 0 ABC (n = 1) Pretreatment = 75.5 Posttreatment = 85 SOT (n = 1) Pretreatment = 60 Posttreatment = 84
Evidence quality score	20/22	16.5/22	8/10
Support for the answer	Yes	Yes	Yes

Abbreviations: ABC = Activities-Specific Balance Confidence; DHI = Dizziness Handicap Inventory; SOT = Sensory Organization Test; TBI = traumatic brain injury.

Implications for Practice, Education, and Future Research

Reported and observed dizziness and imbalance following concussion can be predictors of a prolonged recovery from concussion and may not always resolve spontaneously. Preliminary research on vestibular rehabilitation to treat dizziness and imbalance shows

significant improvement in most, but not all patients. Vestibular rehabilitation should be considered as an option for patients with prolonged dizziness and imbalance following concussion. Patients should be evaluated on a case-by-case basis to determine if vestibular rehabilitation is appropriate for them. Furthermore, athletic trainers should possess the evaluation tools necessary to determine if a concussed individual is a good candidate for

vestibular rehabilitation. These tools include standard postural assessments, such as the BESS, as well as the Vestibular/Ocular Motor Screening (VOMS) and the Dix-Hallpike maneuver to assess for BPPV. Additionally, patient-reported outcomes, such as the DHI, ABC, and the Convergence Insufficiency Symptom Survey (CISS), can be helpful in determining which treatment route to take. Schneider et al.¹¹ also reported that vestibular rehabilitation in combination with cervical rehabilitation can be beneficial for patients who have postconcussion dizziness and imbalance of cervicogenic origin, showing the potential benefits of multimodal therapy.

Once a clinician can determine the specific functional deficiencies of a patient, exercises familiar to athletic trainers can be implemented. Many of the exercises involved in the examined studies are commonly used by athletic trainers to improve balance and proprioception for a multitude of lower extremity injuries. There are five main categories of vestibular exercises: (a) eye-head coordination, (b) sitting balance, (c) standing static balance, (d) standing dynamic balance, and (e) ambulation.³ For each of these exercise types, there are 10 modifiers to progress and regress each exercise in difficulty: (a) the posture with which the exercise is performed, (b) the support surface, (c) the size of the base of support, (d) the trunk position, (e) arm position, (f) the direction of head movements, (g) the directions of whole-body movements, (h) the visual input, (i) the presence of absence of a dual cognitive task, and (j) any other special circumstances.³ Table 3 presents a summary of examples for each modifier.³ Modifications can be molded to fit specific functional deficits of each patient. Clinicians should incorporate both clinician- and patient-reported outcomes measures to effectively assess progress.

Each outcome measure of interest showed substantial improvement as a whole following vestibular rehabilitation. While not every patient made improvement and there was some variability in the magnitude of improvement between patients, the overall

trend was that of decreased imbalance and self-reported dizziness. For the Alsalaheen et al.¹⁰ cohort, dizziness severity decreased from 21 (SD=22; 95% CI=15.5, 26.5) to 12 (SD=18; 95% CI=7.5, 16.5; ES=0.448); ABC increased from 64 (SD=27; 95% CI=57.45, 70.55) to 84 (SD=17; 95% CI=79.88, 88.12; ES=0.89); DHI decreased from 49 (SD=21; 95% CI=43.94, 54.06) to 30 (SD=22; 95% CI=24.7, 35.3; ES=0.88); and SOT composite score increased from 48 (SD=19; 95% CI=39.9, 56.1) to 71 (SD=13; 95% CI=65.46, 76.54; ES=1.41).⁴ For the Kleffellgaard et al.¹ cohort, DHI decreased from 56.5 (SD=12.26; 95% CI=44.24, 68.76) to 32 (SD=23.21; 95% CI=8.97, 55.21; ES=1.32) and BESS tests decreased from 31.5 (SD=2.38; 95% CI=29.12, 33.88) to 16.5 (SD=6.45; 95% CI=10.5, 22.95; ES=3.09).¹ Gottshall and Sessom's⁹ participant had improvements of 9.5, 18, and 24 in the ABC, DHI, and SOT composite scores, respectively. Table 4 averages outcome measures pre- and posttreatment across all studies.

Although there was some variation between studies with regard to their definition of prolonged recovery, the vast majority were symptomatic for at least 21 days before an initial evaluation. For the Alsalaheen et al.¹⁰ cohort, the range of time from injury to initial evaluation was wide (6–2,566 days), however, only 7% of these individuals had an initial evaluation within 3 weeks of injury. This study indicates that, regardless of the magnitude of prolonged recovery, initiation of vestibular rehabilitation seems to be beneficial for resolving symptoms, provided the patient is a good candidate. After the onset of intervention, an individual who was experiencing symptoms for 2 months received the same benefits of an individual who was experiencing symptoms for 6 months.

Concussion recovery continues to be an area of emerging research. Due to this focus, this topic should be revisited in 2 years, or as additional research is published. While the findings were consistent across studies, the level of research was weak. Future research needs to determine appropriate duration and intensity

Table 3 Summary of Vestibular Therapeutic Exercise Modifiers³

Modifier	Options
Posture	Sitting, standing, walking, n/a
Surface	Level, foam, uneven, obstacle, stairs, ramps, n/a
Base of support	Feet-apart, feet together, semi-tandem stance, tandem stance
Trunk position	Upright, leaning, rotated, n/a
Arm position	Weight bearing, close to body, away from body, reaching, carrying, picking up objects, juggling, n/a
Head movement direction	Still, yaw, pitch, roll, n/a
Whole-body movement direction	Anterior-posterior, medial-lateral, multi-directional
Visual input	Eyes closed, eyes open, complex patterns, n/a
Cognitive dual task	Yes, no
Special circumstances	Specific parameters for exercises (e.g., visual targets near or far)

Table 4 Combined Mean Scores and Differences in Outcome Measures

Outcome	n	Pre	Post	Mean Difference
Dizziness severity	64	21	12	9
ABC	69	69.75	84.5	9.5
DHI	74	41.17	20.67	20.5
SOT	23	54	77.5	23.5
BESS	4	31.5	16.5	15

Abbreviations: ABC = Activities-Specific Balance Confidence; BESS = Balance Error Scoring System; DHI = Dizziness Handicap Inventory; SOT = Sensory Organization Test.

guidelines for vestibular therapeutic exercises in a prospective cohort design. In addition, control groups should be included so that the therapeutic effect of time can be taken into account.

CAT Kill Date: May 2021

CATS have limited life and should be revisited approximately 2 years after publication (see <https://doi.org/10.1123/ijatt.2018-0093>).

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