Addressing potential barriers to implementing an exercise program with concussion

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Course Objectives

- Recognize limitations to BCTT with different patient populations
- Identify alternative treatment options for a patient who cannot tolerate standard graduated aerobic exercise
- Identify signs and symptoms of orthostatic intolerance
- Identify assessment tools to assess for orthostatic intolerance
Aberrant response to BCTT

VESTIBULAR AND OCULOMOTOR DEFICITS

CERVICOGENIC DIZZINESS

PHYSIOLOGIC/AUTONOMIC DYSFUNCTION
Vestibular and Oculomotor

**Presentation:**
- Dizziness, headache, nausea, diplopia, blurred vision, fogginess, unsteady.

**Objectives:**
- VOMS, BPPV, DVA, head thrust, head shaking nystagmus, FGA, BESS, balance assessment.

**Treatment/Research:**

**Vestibular rehab** is recommended when deficits are present. Including, static/dynamic balance, VOR, adaptation, habituation, canalith repositioning. 


**Vision therapy:**
- Convergence training
- Ziaks 2019 propose a timeline for vision and vestibular interventions.
Figure 1. Summarized treatment plans for vestibular injuries

- Initial Encounter
- Initial Evaluation
  - Cervical treatment required?
    - Yes: Complete cervical spine treatment until resolved
    - No: Complete together
  - BPPV treatment required?
    - Yes: Complete BPPV treatment each unit until resolved
    - No: Progress to complex evaluation
- Progress to complex evaluation:
  - At 3 weeks progress in addition to cervical and BPPV unless extenuating circumstances
- Progression:
  - 2+ weeks post injury
    - Manual frequency – PRN
    - Vision & Vestibular tx
      - 1 visit/week + daily HEP
  - 2-4 weeks post complex evaluation
    - 1x/week + daily HEP
  - Increase complexity otolntic exercises
  - Add low level vestibulocollis exercises while progressing vision
  - Add binocular vision exercises if appropriate
  - Progress to higher level visco-vestibular exercises, continue binocular exercises
  - Discharge with final home program

Abbreviations:
- PRN – As needed
- VPV – Vertigo Provocative Positional Vertigo
- Tx – Treatment
- HEP – Home Exercise Program

Vision & Vestibular therapy required?
Cervicogenic

Presentation: headache, dizziness, blurred vision, neck pain/stiffness, unsteady, fogginess, light headed

Objectives: ROM, flexion-rotation test, joint mobility testing, ligament testing for instability, DNF endurance test, JPE, smooth pursuit neck-torsion test, head-neck differentiation

Treatment/Research:

- Manual therapy, cervical stabilization and endurance training, cervicocephalic proprioception training, patient education\(^3,11,13\)
- Kennedy 2019: Prospective case series. 90% of patients found to have neck problems contributing to their concussion symptoms\(^11\)
- Schneider 2014: Combination of vestibular + cervical treatment in SRC were ~4x/more likely to be medically cleared than a control group\(^3\)
<table>
<thead>
<tr>
<th>Pathophysiology</th>
<th>Physiologic PCD</th>
<th>Vestibulo-ocular PCD</th>
<th>Cerviogenic PCD</th>
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</thead>
<tbody>
<tr>
<td>Predominant symptoms</td>
<td>Persistent alterations in neuronal depolarization, cell membrane permeability,</td>
<td>Dysfunction of the vestibular and oculomotor symptoms</td>
<td>Muscle trauma and inflammation</td>
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<td></td>
<td>mitochondrial function, cellular metabolism, and cerebral blood flow</td>
<td></td>
<td>Dysfunction of cervical spine proprioception</td>
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<td>Predominant symptoms</td>
<td>Headache exacerbated by physical and cognitive activity</td>
<td>Dizziness, vertigo, nausea, light-headedness, gait instability and postural instability at rest.</td>
<td>Neck pain, stiffness, and decreased range of motion</td>
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<td>Nausea, intermittent vomiting, photophobia, phonophobia, dizziness, fatigue,</td>
<td>Blurred or double vision, difficulty tracking objects, motion sensitivity, photophobia, eye strain or brow-ache, and headache exacerbated by activities that worsen vestibulo-ocular symptoms (i.e. reading)</td>
<td>Occipital headaches exacerbated by head movements and not physical or cognitive activity</td>
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<td>difficulty concentrating, slowed speech</td>
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<td>Light-headedness and postural imbalance</td>
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<td>Physical exam findings</td>
<td>No focal neurological findings</td>
<td>Impairments on standardized balance and gait testing</td>
<td>Decreased cervical lordosis and range of motion</td>
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<td></td>
<td>Elevated resting HR</td>
<td>Impaired VOR, fixation, convergence, horizontal and vertical saccades</td>
<td>Paraspinal and sub-occipital muscle tenderness</td>
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<tr>
<td>Grade treadmill test</td>
<td>Graded treadmill tests are often terminated early due to symptom onset or exacerbation</td>
<td>Patients typically reach maximal exertion without exacerbation of vestibulo-ocular symptoms on graded treadmill tests</td>
<td>Impaired head-neck position sense</td>
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<tr>
<td>Management options</td>
<td>Physical and cognitive rest</td>
<td>Vestibular rehabilitation program</td>
<td>Patients typically reach maximal exertion without exacerbation of cerviogenic symptoms on graded treadmill tests</td>
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<td></td>
<td>School accommodations</td>
<td>Vision therapy program</td>
<td>Cervical spine manual therapy</td>
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<td>Sub-symptom threshold aerobic exercise programs should be considered for adolescent and adult athletes</td>
<td>School accommodations</td>
<td>Head-neck proprioception re-training</td>
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Table 1. Summary of pathophysiology, predominant symptoms, pertinent physical examination findings, graded treadmill test results and treatment options in patients with PCDs.
Physiological

- Orthostatic Intolerance
  - POTS: Postural Orthostatic Tachycardia Syndrome
  - Miranda 2018: 11.4% of 722 patients\textsuperscript{16}
  - Subtypes: Neuropathic, Hypovolemic, Hyperadrenergic
Orthostatic intolerance

How to recognize this

- Subjective reports: dizziness (lightheaded), headache, nausea, reduced mental clarity/brain fog, poor sleep, generalized fatigue - sound familiar?
  - General body pain, heaviness, GI symptoms, poor temperature regulation

- Objective testing:
  - Gold Standard: Head-Up Tilt table test
  - Supine for 30 minutes, BP and HR taken
    - Transition to 70deg upright, vitals taken incrementally for 10 minutes
    - POTS: >30bpm increase from supine HR OR >120bpm
  - Clinic assessment: Can perform 10 minute standing test: > 30 bpm HR increase or 40bpm in adolescents
    - Want to differentiate orthostatic hypotension (20mmHg drop systolic or 10 mmHg in diastolic)
    - Resting HR after 10 minutes of supine then standing HR/BP at 3,5,7, and 10 minutes
Patient recommendations

**Salt:** Please aim for 10 grams of salt per day. In general it is better to consume your salt added to water compared to food. Use any of the following methods:
- Add liberal sea salt to meals (not ideal)
- Nuun brand electrolyte replacement (each tablet contains 360mg sodium, 100mg potassium) 2-6 tablets per day.
- Salt sticks brand electrolyte capsules (215mg sodium, 63mg potassium) 4-8 capsules per day.

**Hydration:** Finding the 'goldilocks dose' of water can be challenging. Please consume at least 2 liters of water per day, although some POTS patients often feel better at up to 4 liters of water per day. Drinking water quickly rather than sipping can be helpful for some patients.

**Exercise:** Exercise can be one of the most important, but one of the most difficult treatments for POTS. Exercising in water can be helpful because the weight of the water 'pushes' circulation to your muscles and organs. Recumbent exercise if often better tolerated. Take frequent rest breaks putting your legs up a wall if you get dizzy or out of breath. This will help get blood circulation out of your legs and into your chest and head. Starting a program with a physical therapist familiar with POTS specific exercise programs to improve outcomes.

**Compression:** recommend getting 2 strengths of compression socks: 15-20mmHg and 30-40mmHg. Wear compression socks during all times of activity, especially standing for longer periods of time. Some patients benefit from wearing compression full time. Some patients benefit from wearing compression leggings, abdominal binder.

**Digestive support:** If you have significant digestive symptoms the following things can be helpful:
- Eat meals slowly in a low stress environment. Avoid drinking liquids during your meal, a small amount is ok. Use of digestive enzymes (Ginger, Iberogast).
Treatment

- **CHOP Protocol**
  - HR training zone calculation\(^{16}\)
    - Heart Rate Reserve (HRR) = Max HR \((220\text{-age})\) - RHR
    - Maximal Steady State (MSS) = 75% HRR + RHR
    - Base Pace: 75-85% MSS
    - Recovery Zone: <Base Pace
  - ~8 Month Protocol\(^{27}\)
    - Month 1-3: Horizontal or seated training
    - Month 4: Upright bike
    - Month 5: Upright exercise (Elliptical, Treadmill)
    - Month 6-8: Upright high intensity training
## Month 1

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<tr>
<th>Sunday</th>
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<tr>
<td>Training Mode 1&lt;br&gt;5-10 min Warm Up&lt;br&gt;3 min Base Pace&lt;br&gt;2 min recovery&lt;br&gt;3 min Base Pace&lt;br&gt;5-10 min Cool Down</td>
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<td>Training Mode 1&lt;br&gt;5-10 min Warm Up&lt;br&gt;4 min Base Pace&lt;br&gt;3 min recovery&lt;br&gt;4 min Base Pace&lt;br&gt;5-10 min Cool Down</td>
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<td>Training Mode 1&lt;br&gt;5-10 min Warm Up&lt;br&gt;7 min Base Pace&lt;br&gt;3 min recovery&lt;br&gt;5 min Base Pace&lt;br&gt;5-10 min Cool Down</td>
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Training Mode 1 = any of supine cycling, recumbent bike, swimming laps with a kick board, rowing, seated stepper  
Recovery = slow down, reduce resistance, get a drink, but don’t stop moving.  
Warm ups and cool downs are done starting very slowly with little or no resistance and leading up to and out of your Base Pace HR zone  
Physical therapist can begin with supine cycling only if a patient is beginning program as wheel-chair bound/bedridden.  
Weight training can be done on the same days as cardio workouts if necessary.
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<tr>
<td></td>
<td>Training Mode 1</td>
<td>Strength Training</td>
<td>Training Mode 2</td>
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<td>10 min Warm Up 30 min Base Pace 10 min Cool Down</td>
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<td>10 min Warm Up 30 min Base Pace 10 min Cool Down</td>
<td>10 min Warm Up 25 min MSS 10 min Cool Down</td>
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<td>10 min Warm Up 35 min Base Pace 10 min Cool Down</td>
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Training Mode 1 = any of Recumbent Biking, Swimming, Rowing
Training Mode 2 = upright bike
Training Mode 3 = Treadmill walking (flat grade), Elliptical (stationary arms)
Training Mode 4 = Treadmill walking (incline), Elliptical (with use of arms). Can progress to jogging if able.
Weight Training can be done on same days as Cardio workouts if necessary.
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10 min Warm Up  
3 min MSS  
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<td>10 min Warm Up 7x2 min Intervals 10 min Cool Down 20 min Recovery</td>
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Training modes are not listed because individuals should continue to progress to upright modes as they can tolerate. We recommend beginning Interval training on the rower, upright bike or elliptical. Can progress to jogging if able. Weight Training can be done on same day as Cardio if necessary.
If not responding to aerobics...

- Seated bike
- Address cervical spine
- Address Vestibular deficits
- Consider Occupational Therapy - vision therapy
- Modify aerobic program to CHOP protocol
DISCUSSION: Case Example

**Subjective history:**

27 year old female. Presents 60 days post SRC- hit with a soccer ball to the side of the head. Unable to return to the game

Initial symptoms: dizziness, blurred vision, headache.

Primary current complaints: difficulty focusing at work as a Real estate agent. Low grade headache all the time worsens with busy environments, loud noises, working on computer. Feels overly tired (naps 1x/day), dizziness/lightheaded when she moves her head and being on her feet for prolonged periods.

Where to start???