Physical Therapy Management of the Post-Concussed Patient

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Cognitive
- Feeling “foggy”
- Feeling “slowed down”
- Difficulty concentrating
- Difficulty remembering

Physical
- Headache
- Dizziness
- Balance Problems
- Visual Problems
- Exercise Intolerance
- Light / Noise Sensitivity
- Numbness/Tingling
- N/V

Emotional
- Irritability
- Sadness
- Nervousness
- Feeling more emotional

Sleep Alterations
- Drowsiness
- Sleeping less
- Sleeping more
- Difficulty falling asleep
Physical Symptoms following Concussion

- **Headache** (generalized) most common symptom, reported to be seen in as many as 75% post-concussed patients.

- **Dizziness** (23-81% cases) and imbalance (68%) are common symptoms after mTBI. (Alsalaheen et al. 2010)

- Physical symptoms that persist for prolonged periods of time often lead to functional limitations, deconditioning and subsequently a reduced quality of life.

**Physical**
- Headache
- Dizziness
- Balance Problems
- Visual Problems
- Exercise Intolerance
- Light / Noise Sensitivity
- Numbness/Tingling
- N/V
Rehabilitation following Concussion
When and who??

- Patients referred to rehabilitation if symptoms do not reside within the normal window of recovery.
  - Adult “7-10 days” vs “1-3 weeks”
  - Children/Adolescents 3-4 weeks
- **Vestibular Therapy** for balance and oculomotor exercises
- **Aerobic Exercise (Exertion) Rehabilitation** for sub symptom threshold exercise.
- **Vision Therapy** for oculomotor dysfunction.
- **Speech Therapy / Occupational Therapy** for memory and executive functioning.

**Physical**
- Headache
- Dizziness
- Balance Problems
- Visual Problems
- Exercise Intolerance
- Light / Noise Sensitivity
- Numbness/Tingling
- N/V
What is the Vestibular System?

Sensory and motor system that functions to detect the position and motion of the head in space. This is essential for:

- **Gaze Stability**
  - Maintains clear vision with head movement via the Vestibular Ocular Reflex (VOR)
  - Eye-Head Coordination
- **Postural Stability**
  - Eye-Neck-Trunk
  - Head stability
- **Coordination**
- **Protection**
  - VSR
Vestibular Rehabilitation

Vestibular Ocular Reflex (VOR)
Vertigo - illusion of movement of self or environment with eyes open or closed.

Oscillopsia - subjective illusion of visual motion with the eyes open only.

Mal de Debarquement - rocking or swaying sensation as if on a ship.

Blurry or double vision.

Nausea and vomiting.

Lightheadedness.

Dysequilibrium - unsteadiness while standing or walking.

*Symptoms are usually brought on or made worse by head movement or position change.

Rehabilitation following Concussion

When and who??

Physical
Headache
Dizziness
Balance Problems
Visual Problems
Exercise Intolerance
Light / Noise Sensitivity
Numbness/Tingling
N/V
Balance Control

Where am I?

Sensory

- Determination of Body Position
- Compare, Select and Combine Senses
- Visual System
- Vestibular System
- Environmental Interaction

Motor

- Choice of Body Movement
- Select and Adjust Muscle Contractile Patterns
- Ankle, Thigh
- Trunk, Neck
- Eye, Head
- Generation of Body Movement

What am I going to do?
Etiology of Dizziness in Concussion

• **Autonomic Dysregulation** (Leddy/Baker – University of Buffalo)
  – Dysregulation of BP which may account for positional dizziness
  – Later in recovery may account for intolerance to exercise, increase in HR
• **Central/Peripheral Vestibular**
  – Oculomotor Abnormalilites
    • Gaze Stability Impairment
• **Post-Traumatic BPPV**
• **Migraine-related dizziness (MRD)**
  – Abnormal DVA
  – Normal Posturography, static posture
• **Anxiety**
• **Cervicogenic Dizziness**
Cervicogenic Dizziness

Diagnosis of exclusion
- Often associated with flexion-extension injury: ‘whiplash’
- Non-vestibular dysfunction
  • No vertigo

Associated Signs
- Ataxia, unsteady gait or postural imbalance
- Headache
- Difficulty concentrating / focusing
- Cervical pain, limited cervical ROM, Cervical mm weakness
- Impaired cervical kinesthetic ability, manifested by increased joint position error
- Occulomotor abnormalities
  • + Smooth Pursuit Neck Torsion Test

Results from a mismatch between the somatosensory information from the cervical spine and input from the visual and vestibular systems
- “non-specific sensation of altered orientation in space and disequilibrium originating from abnormal afferent activity of the neck”
- Furman And Cass (1996)
Rehabilitation Evaluation of the Post-Concussed Patient

- History
  - “Key” to Diagnosis
- Symptom Evaluation
- Oculomotor Testing
- Motion Sensitivity Testing
- Balance testing
- Aerobic Exercise/Tolerance Testing
Evaluation of the Post-Concussed Patient

History

• “Key” to diagnosis

• Nature of initial symptoms
  – Onset
  – Symptoms
  – Duration
  – Frequency
  – Associated symptoms

Investigate!! Ask the following…
• What provokes your symptoms?
• Do you have visual changes?
• Do you have hearing changes?
• Do you have symptoms with changes in position?
• Are you motion sensitive?
• Do you have problems walking in the dark or on uneven surfaces?
• Do you have headaches?
• Do you have symptoms with exertion?
• Have you fallen?
Evaluation of the Post-Concussed Patient Symptom Evaluation

• Instruments should be utilized to quantify highly subjective complaints and assist clinician in tracking recovery.

• Commonly used instruments include:
  - Rivermead Post-Concussion Symptoms Questionnaire
  - Post-Concussion Symptom Checklist
  - ImPACT Post-Concussion Symptom Scale

The Rivermead Post Concussion Symptoms Questionnaire

After a head injury or accident some people experience symptoms which can cause worry or nuisance. We would like to know if you now suffer from any of the symptoms given below. As many of these symptoms occur normally, we would like you to compare yourself now with before the accident. For each one, please circle the number closest to your answer.

0 = Not experienced at all
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Compared with before the accident, do you now (i.e., over the last 24 hours) suffer from:

<table>
<thead>
<tr>
<th>Symptom</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headaches</td>
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<td>Feelings of dizziness</td>
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<td>Nausea and/or vomiting</td>
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<td>Noise sensitivity, easily upset by loud noise</td>
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<td>Sleep disturbance</td>
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<td>Fatigue, tiring more easily</td>
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<td>Being irritable, easily angered</td>
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<td>Feeling depressed or tearful</td>
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<td>Feeling frustrated or impatient</td>
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<td>Forgetfulness, poor memory</td>
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<td>Poor concentration</td>
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<td>Taking longer to think</td>
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<td>Blurred vision</td>
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<tr>
<td>Light sensitivity, easily upset by bright light</td>
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<tr>
<td>Double vision</td>
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<tr>
<td>Restlessness</td>
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</table>

Are you experiencing any other difficulties?

1. .................................................. 0 1 2 3 4
2. .................................................. 0 1 2 3 4

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Evaluation of the Post-Concussed Patient
Oculomotor Testing

- Ocular Motility (ROM)
- Smooth pursuits
- Saccades
  - King Devick Test
- Nystagmus
  - Spontaneous
  - Gaze-evoked
  - Direction changing
- VOR
- Dynamic Visual Acuity (DVA)
  - Difference b/w static visual acuity and visual acuity with head oscillating at 2 Hz.
  - Normal – 2 line or less difference
## Evaluation of the Post-Concussed Patient

### Vertiginous Positions

### Motion Sensitivity Testing
- Motion sensitivity quotient (MSQ)
- Hallpike-Dix Test
- Optokinetic Testing

### Motion Sensitivity Score Table

<table>
<thead>
<tr>
<th>Positional Testing</th>
<th>Baseline</th>
<th>Symptoms Intensity</th>
<th>Symptom Duration</th>
<th>Score (I-D)</th>
<th>Nystagmus</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>1. Sitting up</td>
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<td>2. Supine</td>
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<td>3. Semi-sitting</td>
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<td>4. Supine sitting</td>
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<tr>
<td>5. Left decubitus</td>
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<tr>
<td>6. semi-sitting</td>
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<tr>
<td>7. Right decubitus</td>
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<td>8. Semi-sitting</td>
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<td>9. Sitting nose to</td>
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<td></td>
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<tr>
<td>left knee</td>
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<td>10. Sitting</td>
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<tr>
<td>11. Sitting nose to</td>
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<tr>
<td>right knee</td>
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<tr>
<td>12. Sitting</td>
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<tr>
<td>13. Sitting nose to</td>
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<tr>
<td>each shoulder</td>
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<td>14. Straighten</td>
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<td>15. 100 degree turn to the right</td>
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<tr>
<td>16. 100 degree turn to left</td>
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<tr>
<td><strong>Total</strong></td>
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<td></td>
<td><strong>MSQ</strong></td>
</tr>
</tbody>
</table>

### MSQ Calculation

\[
\text{MSQ} = \frac{\text{Total Positions} \times \text{Total Score}}{20.48}
\]

### Abbreviations
- MSQ: Motion sensitivity quotient
- I-D: Improvement indicator

### Improvement Indicators
- Decreased number of provoking positions
- Increased number of reps before symptom occurrence
- Decreased intensity of symptom
- Shorter duration of symptoms
Evaluation of the Post-Concussed Patient Balance

**Static**
- Rhomberg / Sharpened Rhomberg
- Balance Error Scoring System (BESS)

**Dynamic**
- Dynamic Gait Index (DGI)
- Functional Gait Assessment (FGA)

**Sensory Integration / Organization**
- Attempts to measure the way vestibular, visual and somatosensory interaction allow us to maintain our balance against gravity
  - Posturography
    - SOT
    - CTSIB
    - mCTSIB
    - SET Test
Evaluation of the Post-Concussed Patient
Aerobic Exercise (Exertion) Testing

Leddy et al 2007
• Ongoing central and systemic physiologic regulatory dysfunction causes PCS symptoms
• Symptoms may be reduced or alleviated by individualized sub-symptom threshold aerobic exercise rehabilitation

Leddy et al 2010
• Studied concussed athletes and non-athletes in acute/chronic phase and identified a symptom threshold (ST) for HR.
• Developed a graded treadmill test, later named the Buffalo Concussion Treadmill Test (BCTT) to identify the ST and guide threshold for exertion rehabilitation.
Evaluation of the Post-Concussed Patient Aerobic Exercise (Exertion) Testing

Leddy et al 2010
http://concussion.buffalo.edu/links.html
Rehabilitation
Treatment of Post-Concussion

Vestibular Rehabilitation to promote:
• Adaptation (VOR)
  – Treatment of choice for patients with impaired gaze stability.
  – VOR initiates the adaptation process via motor learning of oculomotor firing grading the retinal ocular slip.

• Habituation
  – This is the treatment of choice for patients with positional dizziness.
  – Characterized by a decline in symptom response to a repeated noxious stimuli (specific movement).

Manual Therapy
• BPPV
  – Replace the otoconia into the vestibule via the appropriate repositioning maneuver.

• Cervicogenic Dizziness
  – Manual therapy and muscle relaxants are used to improve ROM and decrease cervical muscle pain and spasm.

• Balance Training
  – Exercise should incorporate head movement and the use of visual, somatosensory, and vestibular cues by altering the visual and somatosensory environment.

Aerobic Exercise (Exertion) Rehabilitation
## Rehabilitation

### Treatment of Post-Concussion

<table>
<thead>
<tr>
<th>Stage of Rehabilitation</th>
<th>PT – Autonomic Dysfunction</th>
<th>PT- Vestibular-Ocular Dysfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage 1</strong>&lt;br&gt;Criteria: Unable to walk a straight line with normal/narrow BOS, oculomotor dysfunction, Increased baseline HR&lt;br&gt;• Exercise in quiet area&lt;br&gt;• No impact activities&lt;br&gt;• Vestibular/balance by specialist&lt;br&gt;• Limit head movement</td>
<td>30-40% Target HR</td>
<td>• Stationary Aerobic (bike)&lt;br&gt;• Static balance activities&lt;br&gt;• Exercises that limit head movement (weight machines, squats/lunges)&lt;br&gt;• Core exercise without head movement</td>
</tr>
<tr>
<td><strong>Stage 2</strong>&lt;br&gt;Criteria: Symptoms continue to be provoked by exercise&lt;br&gt;• Exercise in gym areas&lt;br&gt;• Use various equipment&lt;br&gt;• Allow some positional changes</td>
<td>40-60% Target HR</td>
<td>• Progressive dynamic aerobic conditioning (elliptical &gt; Jump Rope &gt; walk to jog on TM)&lt;br&gt;• Balance activities, resistance and core exercise with head movements&lt;br&gt;• Low intensity sport-specific activities</td>
</tr>
</tbody>
</table>

Target HR = (Max HR - Rest HR x %) + Rest HR  
Max HR = 220 - age

Adapted from UPMC Sports Medicine Concussion Program Guidelines
Rehabilitation Treatment of Post-Concussion

<table>
<thead>
<tr>
<th>Stage of Rehabilitation</th>
<th>PT – Autonomic Dysfunction</th>
<th>PT- Vestibular-Ocular Dysfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 3</td>
<td>60-80% Target HR</td>
<td>• Moderately aggressive aerobic exercise (intervals, stair running)</td>
</tr>
<tr>
<td>Criteria: No symptoms at rest or during</td>
<td></td>
<td>• All forms of strength exercise</td>
</tr>
<tr>
<td>activity</td>
<td></td>
<td>• Dynamic warm ups</td>
</tr>
<tr>
<td>• Any environment OK</td>
<td></td>
<td>• Impact activities (plyometrics, running)</td>
</tr>
<tr>
<td>• Integrate strength, conditioning and</td>
<td></td>
<td>• More aggressive sport-specific activities (80%)</td>
</tr>
<tr>
<td>balance</td>
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<td></td>
</tr>
<tr>
<td>Stage 4</td>
<td>80% Target HR</td>
<td>80% max exertion sport-specific activities, avoiding contact</td>
</tr>
<tr>
<td>• Avoid contact</td>
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</tr>
<tr>
<td>Stage 5</td>
<td>Full Exertion</td>
<td>Full physical training activities with contact</td>
</tr>
<tr>
<td>• Initiate contact as appropriate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Full exertion for sport activities</td>
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</tr>
</tbody>
</table>

Adapted from UPMC Sports Medicine Concussion Program Guidelines
Post-Concussion Management
Aerobic Exercise (Exertion) Rehabilitation

Buffalo Concussion RTP Protocol

• Aerobic exercise 5-6x/wk at 80% HR of symptom threshold.
• Increase 5-10 bpm 1-2 weeks depending on patient response.
• Goal- Ability to exercise to voluntary exhaustion without exacerbation of PCS symptoms
Post-Concussion Management
Does Rehabilitation work?

Vestibular Rehabilitation

Alsalaheen et al 2010, reviewed 84 concussed patients retrospectively
- Significant improvement in subjective dizziness (DHI / ABC), gait/balance after 12 weeks of PT

Gottshall (2010) found improvements in gaze stability (DVA) and gait/balance after 12 weeks vestibular therapy in soldiers with mTBI.

Hoffer et al 2004 descriptive study of 58 post-mTBI solders undergoing vestibular rehab.
- BPPV group resolved within 1 week
- MRD group resolved within 8 weeks
- “Spacial Disorientation” group required up to 39 weeks.
  - Abnormal DVA, Posturography
  - Abnormal static posture/Gait (Romberg/DGI)

Aerobic Exercise (Exertion) Rehabilitation

- Studied concussed athletes and non-athletes in chronic phase.
  - Abnormal static posture/gait (Romberg/DGI)
- 72% able to return to full daily functioning

Evidence-based research is limited!
Thank You