Concussion Management for the Physical Therapist
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Sheltering Arms – Total Concussion Care
Learning Objectives

• Identify common symptoms and the physiology associated with concussion injury
• Identify the physical therapist role in concussion management.
• Identify common red flags that warrant referral to alternative healthcare professionals.
• Identify examination and intervention methods for this population
• Review recent updates to research regarding concussion management
Who am I?

• Graduated from Duke University’s Doctor of Physical Therapy program in 2013
• 2 years clinical experience with specialization in concussion care
• Started with Sheltering Arms in August 2013
• Concussion Clinician for *Total Concussion Care* Program at Sheltering Arms in Mechanicsville
Concussion

OVERVIEW
Why Concussion?

• Long neglected population
• Constantly evolving and developing area of practice
• It is an injury that covers a wide spectrum of patient populations
• Effects can be debilitating and with proper intervention can improve patient function and return to prior functional levels
• Wide spread media attention
Definition

Concussion

- Complex pathophysiologic process affecting the brain
- Induced by traumatic biomechanical forces due to direct or indirect forces to the head.
- Constellation of physical, cognitive, emotional or sleep-related symptoms, +/- LOC.
- Neuroimaging typically normal
- Duration of symptoms is highly variable - from several minutes to days, weeks, months, or longer in some cases

*Center for Disease Control and Prevention: Heads up: Brain injury in your practice, Updated 2007

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Incidence rate
- Majority of TBI are mTBI or concussions (75-85%)
- Annual rate of mTBI is 130-546 per 100,000 persons
- Approximately 300,000 sports-related concussions occur in the United States every year

Public health & cost
- Estimated annual cost (direct and indirect) in U.S = $12 -17 billion
- Negative effect on psychological well being and health related quality of life (HRQOL)
- Higher family burden and emotional distress

(http://www.cdc.gov/injury/about/focus-tbi.html)
Age-Specific Considerations

- 70.5% of sports & recreation-related TBI ED visits were among persons aged 10-19 years.

- This age group requires clear guidelines for:
  - activity modifications
  - academic accommodations

- Goal: **Return to previous levels of activity**
  - However, with athletes in particular, it is essential to take them through a *progressive, stepwise return to play protocol* to ensure *safe* return to play.
Sport-Specific Considerations

• Activities associated with most ED visits for TBI related injuries include:
  – Bicycling
  – Basketball
  – Football
  – Soccer
  – Playground accidents

• Football and girl’s soccer hold the highest risk for each gender
  – In general, collision sports such as football and ice hockey have the highest rates of concussion
  – A recent study found that the incidence of concussion in football at all levels breaks down to at least one concussion being sustained by:
    • 1 in 30 youth players (ages 5-14)
    • 1 in 14 high school players
    • 1 in 20 NCAA football players
Pathophysiology of Concussion

- Metabolic crisis, resulting in an ↑ in energy demand with a ↓ in blood flow as a result of concussion.

- May also be diffuse shearing of the axons due to the movement of the brain within the skull.

- It is important during this time of the crisis to not get hit again as well as to not stress the brain:
  - Cognitive and physical rest in the early stages of recovery.

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Symptoms & Symptom Management

- Concussion management & recovery
  - Focused on symptom management throughout
- Symptoms
  - Predictors of outcomes and overall prognosis.
- Early stages of concussion recovery
  - Monitor symptom progression, resolution and variability.
Concussion Symptoms

- **COGNITIVE SYMPTOMS**
  - fogginess, difficulty concentrating, memory deficits, cognitive fatigue

- **SOMATIC SYMPTOMS**
  - Headache, dizziness, nausea, light/sound sensitivity

- **SLEEP ALTERATIONS**
  - difficulty falling asleep, fragmented sleep, too much/little sleep

- **MOOD DISRUPTION**
  - irritability, feeling sad, anxiety

(Lovell 2006)
What Affects Recovery?

- Adolescents more vulnerable
- **STRESS!!!!**
- Past Medical History
  - Previous concussions
  - Migraines
  - Visual impairments
  - ADHD/Learning disability
  - Mood disorders
- Symptoms at time of injury
  - Dizziness*
  - Amnesia
  - LOC
  - Fogginess

- Age
- Exertion
- Gender
- Migraine
- Repetitive concussion
- Acute markers of TBI: LOC, amnesia, confusion
- Subacute symptoms
  - Memory problems & fogginess
  - Anxiety & noise sensitivity

(Lau et al 2011)
Evidence-Based Practice: Rest

• Recent study in Journal of Pediatrics from 11/14 looked at the benefits for strict rest after concussion
• Randomized controlled trial
  – 99 pts age 11-22 that presented to ED within 24 hours of concussion
  – Completed neurocognitive, balance and symptom assessment in ED
  – Randomized to:
    • Intervention group – strict rest for 5 days and
    • Control group – usual care, 1-2 days of rest and then gradual step wise return to previous activities

– Results
  • Intervention group had less attendance for school and after school at days 2 and 5
  • No clinically significant difference on neurocognitive and balance assessments
  • *Intervention group reported more daily postconcussive symptoms (over 10 days total score 187.9 vs. 131.9) and slower symptom resolution*

– Conclusion
  • Recommending strict rest after concussion for 5 days added NO benefit to concussion recovery as compared to the usual care
Clinical Trajectories

Risk Factors
- Previous concussions
- Migraine
- LD/ADHD
- Sex
- Age
- Motion Sensitivity/Ocular history

Concussion Clinical Trajectories
- Vestibular
- Ocular
- Cognitive
- Migraine
- Anxiety/Mood
- Cervical

Treatment and Rehab Pathways
- Medication management
- Vestibular Therapy
- Vision therapy
- Exercise prescription
It takes a village...

- Parents
- Pediatrician
- Physician Specialists
- Medical Psychologist, Neuropsychologist
- Physical Therapist
- Coach
- Athletic Trainer
- Counselor
- Teacher
- School
- Community
Concussion – Physical Therapist

VESTIBULAR AND OCULOMOTOR IMPAIRMENTS
PT Evaluation

Vestibular Therapy

Sub-symptom threshold exercise prescription

Exertional Therapy:
Return to Activity

Exertional Therapy

Return to Activity
Impairments

- Oculomotor Dysfunction
- Vestibular Impairments
- Balance Impairments
- Cervical Impairments
- Autonomic dysfunction/physiologic impairments
Physical Therapy Intervention

- Concussion therapy is focused on neurological impairments with heavy emphasis on the vestibular system.
- Physical therapists are uniquely qualified to help manage and treat this population:
  - Vestibular therapy (Al Salaheen, 2010)
  - Manual therapy for cervical impairments
  - Exertional therapy for return to activity/play with continued emphasis on testing the vestibular system.
PT Evaluation

- Detailed history
- Strength/ROM
- Oculomotor exam
- Vestibular testing
- Balance
- Gait
- Education on concussion symptoms and activity modifications
Evaluation – Red Flags

- REFER TO NEUROLOGY IF YOU SEE ANY OF THE BELOW AS A NEW SYMPTOM:
  - visual field cuts
  - hyper/hypo deviations with cover/uncover test
  - dysconjugate eye movements
  - significant memory loss – persistent
  - significant one sided weakness
  - seizures – new onset

- REFER TO ENT FOR:
  - one sided hearing loss or significant ringing or aural symptoms
**Evaluation – Red Flags**

- **REFER TO ORTHO OR NEED FOR FURTHER WORK UP:**
  * for persistent neck complaints and/or report of numbness or tingling

- **REFER TO PM&R FOR BELOW:**
  * significant difficulty with sleep regulation
  * persistent headaches
  * significant difficulty with concentration
  * guidance with school and/or work accommodations
  * when issues are not resolving with PT for further recommendations or specialist referrals
Exertional/Return to play

- Testing vs Rehab
- Graded exertional return to sport/activity
  - 5 stages; including aerobic, strength, stretching and dynamic exercises
  - Include head/body position changes to test the vestibular system
  - Include balance and dual tasking as needed
    - When symptom free
      » RTP decisions; collaborative effort
      » Clear for activity
    - If symptomatic
      » Symptom exacerbation
      » Establish thresholds
Evaluation – Subjective

• There are four key areas to investigate in the subjective portion of the therapist’s evaluation:
  – (1) mechanism of injury;
  – (2) symptom reporting and management;
  – (3) past medical history
  – (4) pain

• We use three questionnaires that the patient fills out before the evaluation and we use to track progress throughout their recovery
  – Dizziness Handicap Inventory (DHI)
  – Post Concussion Symptom Scale (PCSS)
  – Neck Disability Index (NDI)
considerations: Research has shown that there are certain things in a patient’s PMH that can affect overall recovery and indicate a risk for prolonged recovery.

The most pertinent factors at this time:
- previous history of concussion,
- personal or family history of migraine
- personal or family history of visual impairments
- personal or family history of anxiety and/or mood disorders
- personal and or family history of learning disabilities or ADHD.

Clinical history questionnaire
The primary areas of focus in the objective portion of the concussion evaluation are:

1. strength/ROM
2. oculomotor motor screen
3. vestibular testing
4. balance testing/gait
Objective – Oculomotor Exam

Oculomotor exam
– Convergence/divergence
– smooth pursuits
– saccades
– gaze holding in 9 cardinal planes
– King Devick Test (assesses reading saccade function) (Dhawan, Starling, et al.)
King Devick Test

- Remove from play sideline assessment
  - Parents or coaches can administer
  - 2 minute test
  - Athlete must read single digit numbers across cards or an iPAD
  - Any deviation from baseline score results in recommendation for remove from play for further evaluation by a licensed professional
  - Screens for:
    - Saccades (eye movements)
    - Attention
    - Concentration
    - Speech/Language
    - Other areas of brain function

- **Vision testing is additive to the sideline assessment of sports – related concussion**
Progressively get harder with each card

King Devick Cards
Oculomotor Dysfunction

Ocular Motor Dysfunction following mTBI [blast-related]

*(Capo-Aponte et. Al Military Medicine 2012)*

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<thead>
<tr>
<th>Condition</th>
<th>% mTBI n=20</th>
<th>% Controls n = 20</th>
<th>p-value</th>
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<tr>
<td>Ocular Misalignments (Vertical Phoria)</td>
<td>55%</td>
<td>5%</td>
<td>0.0012</td>
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<tr>
<td>Ocular Misalignment (Horizontal Phoria)</td>
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<td>0.0084</td>
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<td>65%</td>
<td>15%</td>
<td>0.0031</td>
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<tr>
<td>Convergence Insufficiency</td>
<td>55%</td>
<td>5%</td>
<td>0.0012</td>
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<tr>
<td>Saccadic Impairment</td>
<td>30%</td>
<td>0%</td>
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<tr>
<td>Pursuit Impairment</td>
<td>60%</td>
<td>0%</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
Objective – Vestibular Exam

- Vestibular Exam
  - VOR x 1 viewing (active) first slow and then faster (in all 3 planes, Pitch, roll and yaw)
  - Dix Hallpike if indicated (based on symptom reporting)
  - Dynamic Visual Acuity
  - Gaze Stabilization
  - Motion Sensitivity Quotient (MSQ)
Vestibular Exam – Supporting Evidence

• Studies found that impairments with gaze stability were present for as long as 4 weeks post concussion even with interventions. 

• Another study found that there was evidence to support meaningful improvement in target following and DVA after 8 weeks of vestibular therapy and 12 weeks for gaze stabilization impairments 

• MSQ has been determined to have good sensitivity and specificity for detecting motion-provoked dizziness. 
  – Patients reporting motion sensitivity following concussion should be assessed with the use of the MSQ to determine which position changes are symptom provoking.
Vestibular Ocular Motor Screen

- Clinical assessment used at time of initial evaluation as well as on re-evaluations/discharges as needed
- Symptoms measured at baseline and with testing:
  - Headache
  - Dizziness
  - Nausea
  - Fogginess
- Testing
  - Smooth pursuit
  - Saccades
  - Convergence
  - VOR x 1
  - Visual motion sensitivity (VOR cancellation)

Demonstration Video - 2
• Vestibular-ocular dysfunction (VOD) in acute sports related concussion (SRC) and postconcussion syndrome (PCS)
  – Postconcussion syndrome defined here as those with symptoms lasting > 1 month

• Findings:
  – Median duration of symptoms
    • Those with SRC and VOD: 40 days
    • Those with SRC without VOD: 21 days
  – Statistically significant increase in the adjusted odds of developing PCS among patients with acute SRC who had VOD than those without

Objective – Balance Testing and Gait

**Considerations:** Balance deficits are often reported in the first week after injury and typically are one of the first things to recover.
- 43% of athletes report balance dysfunction as an early symptom following sports related concussion (Lovell 2004)

- Postural Control assessment should be combined with other evaluative measures to gain the highest sensitivity to concussive injuries (Broglio, 2007)

- Balance dysfunction may resolve more quickly than other symptoms following concussion (Catena 2011)

- BESS test designed specifically for concussed athletes – accurate only within 1-3 days post injury (Broglio 2009, Peterson 2003)
Vestibular Impairments

**Studies that have used the SOT to evaluate balance in collegiate athletes and military personnel have consistently demonstrated a primarily vestibular pattern of balance impairment on sensory analysis in contrast to vision or somatosensory based patterns**
Evidence-Based Practice: Objective Tests

- Objective Testing of Children with Dizziness and Balance Complaints Following Sports Related concussions
- 42 pts –
  - 25 girls and 17 boys
  - Age range 8-18 – avg 13.9 +/- 2.4 years
- Testing included SOT, VNG, bithermal caloric test, sinusoidal harmonic rotation chair test, DVAT, cervical vestibular evoked myogenic potential (cVEMP) test and static subjective visual vertical test
  - *all performed by an audiologist
- Avg time between initial concussion and vestibular testing 26 +/- 20 weeks
- Only 4% of the 42 pts had completely normal vestibular and balance test battery
- 55% underwent DVAT testing and of those 57% were abnormal;
- 40% who had SOT testing were abnormal
- 25% abnormal VNG
- Based on testing results –
  
  ***abnormal DVAT results seen in this study and in others may not reflect a direct injury to the peripheral vestibular system from concussion but may instead result from impairment of central integration of visual and vestibular stimuli at the central integration of visual and vestibular stimuli at the level of the brainstem or cerebellum***
Cervical Impairments

- AROM/PROM
- Sensation
- Palpation
- Joint stability testing
- Strength testing
- Manual therapy as indicated
Cervicovestibular rehabilitation in sport-related concussion: a RCT

- Persistent symptoms of dizziness, neck pain and/or headaches post sports-related concussion
- Control group: postural education, ROM, cognitive and physical rest until asymptomatic then RTP
- Intervention group: cervical spine and vestibular rehab
- **Conclusion**: intervention group was 3.91 times more likely to be medically cleared by 8 weeks
Physiologic/Autonomic Dysfunction: When can I exercise?

- Research has shown that the Balke Treadmill protocol has been an effective tool to help identify symptom reproduction in post concussion syndrome.
- It has also been rated for reliability for accurately reproducing maximal heart rate and systolic blood pressure of symptom reproduction in those with PCS.
- Based on these findings it is useful to determine sub symptom threshold exercise prescription for those that are still experiencing symptoms as well as determining readiness to initiate the return to play/activity protocol.

Evidence-Based Practice: Physiological Markers

- Some patients with PCS have difficulty tolerating return to exercise
  - May have inability to pass exertional testing due to symptom onset
- Found to be a result of altered cerebral blood flow (CBF) regulation due to reduced $CO_2$ sensitivity
  - Hypothesized to then cause symptoms of headache and dizziness at threshold intensity
- Utilization of a progressive subthreshold exercise program
  - Increased $CO_2$ sensitivity to near normal levels
  - Improved exercise tolerance with ability to exercise to exhaustion without symptom onset
- Suggests that “return of normal control of exercise CBF and of exercise tolerance could be objective physiological markers of recovery for concussion, which has implications for establishing prognosis and preventing premature return to sport, activity, or military duty
Another study that looked at sub symptom threshold exercise prescription for treatment of post concussion syndrome concluded that overall those who participated in the exercise rehabilitation program returned to full daily functioning.

(Baker et al. Rehabilitation Research and Practice. 2012)
Concussion

RETURN TO PLAY PROTOCOLS
Return to Play/Activity

- Symptom management continues even with RTP

- Returning an athlete to play prior to full resolution of the concussion can have negative effects
  - *Research has shown that student athletes who have engaged in high levels of activity in the weeks following a concussion had increased symptoms, worsened neurocognitive data, and significantly longer recovery times* (Majerske et al. J of Athletic Training 2008)
Return to Play/Activity

- The Return to Play protocol
  - 5 stages
  - Largely based on the protocol that is being used by University of Pittsburgh Medical Center
  - Guidelines recommended by The 4th International Conference on Concussion In Sport.
Return to Play Criteria

- Symptom free at rest
- Clear oculomotor/Vestibular and balance exam
- Symptom free with cognitive/physical exertion
- Full day/schedule/load at school
- Off medications* *
- Normal neurocognitive data – both baseline and post exertion for optimal clearance*
RTP: Exertion Therapy Post Concussion

- Patients should be symptom free for 24 hours prior to progressing to the next stage (cannot complete two stages in one day). If the patient reports symptoms during any stage, terminate the activity; allow the patient to recover and rest until symptom free.

The next session should return the patient to the same stage and then repeat.

- If patient presents with baseline symptoms:
  - ensure those symptoms remain at the same level throughout the session
  - complete each stage 3 times with same report before progressing to the next stage.
Sport Specific Return to Play Guidelines

• Developed by Children’s Healthcare of Atlanta
  – Based on the 7 stage RTP developed at the ICCS
• Football, gymnastics, cheerleading, wrestling, soccer, basketball, lacrosse, baseball, softball, and ice hockey
• Added a moderate activity step highlighted by resistance training
• Included non-contact and light contact in a sport specific fashion (May, Marshall, Burns, et al.)
Concussion

CASE STUDY
Summary

- Concussion & PCS are disabling conditions in the general population and athletes alike
- Individualized approach to treatment
- Interdisciplinary management is necessary
- Research is ongoing across all areas of management and changing daily
References


References

References