Rehabilitation of Concussion in High School Athletes

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Conflict of interest statement
• Bara Alsalaheen
  ➢ Member of the APTA concussion CPG
• Ryan Bean
  ➢ Nothing to disclose

Concussion and Physical therapy
• Centers for Disease Control & Prevention Taskforce
• APTA Clinical Practice Guidelines
• Legislative updates!

Concussion & PT Practice

Number of patients with concussion seen within the last year

n = 1,278

Yorke A., Alsalaheen, in press, PTJ

Concussion & PT Practice

Time between concussion & PT

n = 1,278

Yorke A., Alsalaheen, in press, PTJ

PTs & Knowledge of legislation

• Does the state in which you primarily practice in as a physical therapist have a law specifically addressing concussion sustained in youth athletes?

Incorrect answer 37%

n = 775

Yorke A., Alsalaheen, in press, PTJ
PTs & Knowledge of legislation

- Does the law in your state specifically addressing sustained in youth athletes list physical therapists as a health care professional designated to provide clearance to return to play for youth athletes?

Incorrect answer 43%

Yorke A., Alsalaheen, in press, PTJ

Concussion Law in the State of Michigan

"The State of Michigan requires that a youth athlete, who has been removed from physical participation in an athletic activity, shall not return to physical activity until he or she has been evaluated by an appropriate health professional and receives written clearance"

- MHSAA administrative roles
  - MD, DO, PA

What is different about adolescent concussions

- Do adolescents take longer to recover from concussion?
- Are adolescent athletes at higher risks of “sustaining” concussion?
- Cervical musculature and neuromusculoskeletal maturation?

Do adolescents take longer to recover from concussion? Cognitive recovery Vs. Resolution of symptoms

Critical point for age effects?

Cervical musculature and neuromusculoskeletal maturation
Concussion injury VS. Clinical diagnosis?

- The diagnosis of concussion depends on:
  1. Biomechanical force (direct or indirect)
  2. The level of diffuse functional network pathology
  3. The “symptom generating” threshold by the brain

Current Common diagnostic processes?

- Mechanism informed diagnosis?
- Testing informed diagnosis?
- Symptoms informed diagnosis?

Mechanism-informed diagnosis?

Testing informed diagnosis?

Limitations of the current diagnostic models

- Mechanism-based diagnosis are limited and not predictive of the course of recovery
- NO test can diagnose concussions
- Symptoms are NOT specific to concussion

Therefore the diagnosis of concussion is a clinical diagnosis!
Clinical diagnosis!

- Concussion dichotomy (yes/no)?
- Concussion spectrum!
- Certainty in the diagnosis of concussion
- Possible, probable, definite concussion

(Kutcher et al. 2014)

- Since symptoms may develop overtime, the certainty can change over the first few days

Concussion management

1. Establish a clinical diagnosis
   - Provide specific instructions about rest and restrictions (absolute and relative rest)

2. Serial multi-faceted assessment

3. Resolution of symptom at rest

4. Gradual return to exertion

5. Return to full participation

Rest and exertion after concussion

- Complete rest exceeding 3 days is probably not helpful
- Gradual resumption of activities should begin as soon as tolerated
- Supervised exercise may benefit patients with persistent symptoms

Kutcher et al., 2014

Rest and exertion after concussion

- RTC
  - Control group – “Usual care”
    - Rest 1-2 days and then return to school and a stepwise return to physical activity after the patient’s symptoms have resolved
  - Intervention group – “Strict Rest”
    - Recommendations from physician and discharge instructions to maintain 5 days of strict rest at home (no school, no work, nor physical activity)

Pediatrics, February 2015

Rest and exertion after concussion

- Recommending strict rest for adolescents immediately after concussion offered no added benefit over the usual care.
- This strict rest may have contributed to increased symptoms reporting

Benefits of Strict Rest After Acute Concussion: A Randomized Controlled Trial

Pediatrics, February 2015
Typical recovery vs. prolonged recovery

- Typical recovery
  - 10 days
  - 7-14 days
  - 21 days
- Who does “worse”? 
- Age?
- Gender?
- Dizziness?
- Fogginess?
- ADHD/LD?

Concussion and the one size fits all approach!

- Less global and more delineated signs and symptoms
- Concussion tests has very minimal to no value!
- Clinical expertise and possible referral network is a key

Examples of proposed categories

- Vestibulo-ocular
- Cervicogenic
- Physiological
- Vestibular
- Ocular-Motor
- Cervical
- Cognitive
- Migraine
- Mood/anxiety

Management of patients with protracted recovery

- Categories are not mutually exclusive
- Patients may crossover from one group to another
- Specific rehabilitation assessment and intervention

Who are the Players in Concussion Management?

- Person with the concussion
- Parents
- School/ Employers (teachers, AD, ATCs, adm)
- Health Care Providers
  - ER
  - Orthopaedic Surgeon
  - Pediatrician
  - ATCs
  - PCP
  - PM&R
  - Clinical Neuropsychologist
  - Physical Therapists
  - Neurologist
  - Neurosurgeon
  - Behavioral Optometry
  - Vision therapist
  - Cognitive/ Speech therapist

Considerations in determining the categories of protracted recovery

<table>
<thead>
<tr>
<th>Symptom provocation profile</th>
<th>Non-injury related factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes based on school days vs. weekends</td>
<td>Pre-existing signs/symptoms (migraine, ADHD/LD)</td>
</tr>
<tr>
<td>Changes based on location (class, hallway, cafeteria, gym, football field, etc)</td>
<td>Peers pressure, upcoming competition, college scholarships, etc!</td>
</tr>
<tr>
<td>Changes based on cognitive or physical exertion</td>
<td></td>
</tr>
</tbody>
</table>
Zurich Return to play recommendations

Graded exertional Therapy

- What does exertion mean?
- Variations based on patient previous presentation
- Sport-specific tasks

Exertional Physical Therapy

- Times since injury may vary!
- Asymptomatic, minimal symptoms at rest
- Others (Anxiety, migraine)

- Screenings
  - Screen for cervical involvement
  - Screen for vestibular impairments
  - Screen for ocular-Motor impairments

Exertional Rehabilitation

- Physiologic based model: Stages vary by heart rate max with each stage progressing the amount of exertion. (e.g. Graded Treadmill Test)
- Symptom based model: Stages vary by movement/ vestibular impairments with each stage progressing into more dynamic movements and more physical exertion

- A combined model of both

Example of exertional Protocol (Graded Treadmill Test)

- Initial exercise prescription:
  - 0 inclination at 3.3 mph
- Progression:
  - Increase inclination by 2% after 1 min, 1% @every minute increment
- Measures:
  - RPE/HR/BP, Symptoms, VO2 Max
- Termination:
  - increase in symptoms

Example of exertional Protocol (Graded Treadmill Test)

- 12 participants
- Exercise:
  - @ 80% of baseline treadmill HR
  - 1/day, 5-6 times/week
- Outcomes:
  - Full return to sport/ work in all participants
Considerations

- Symptom emergence:
  - Physiologic exertion VS. vestibular exertion!

- Feasibility:

- Sub-symptom threshold

Stage I

- Limit the following:
  - Head movement
  - Impact
  - External weights
  - Noise (done in a quiet area)
  - Position change
  - Dual task

Hockey Player Stage I

Stage II

- Add head movement
- Add positional changes using different equipment
- Introduce busier environments (gym areas)
- Add low level dual tasks (counting repetitions)

Hockey Player Stage II

Stage IIIA

- Add more aggressive intensity (e.g. add resistance)
- Add higher body impact activities
- Add concentration challenges (count backwards by 7)
- Strength, conditioning, coordination
Hockey Player Stage IIIA

Stage IIIB
- Maximum sport-specific exertion
- Avoiding contact

Hockey Player Stage IIIB

Stage IV
- Full impact, full contact sport-specific drills

Hockey Player Stage IV

Exertional Program in a football player (Stage I)

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Exertional Program in a football player (Stage II)

Exertional Program in a football player (Stage IIIA)

Exertional Program in football player (Stage IIIB)

Exertional Program in a football player (Stage IV)

- McCrory et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012

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Cervicogenic

• Characterized by concussion symptoms and impairments caused by dysfunction of the cervical spine somatosensory system [96, et al. 2013]
  - Neck pain
  - Stiffness
  - Decreased ROM
  - Headache!!!
  - Dizziness?

• There is a strong association with whiplash induced neck injuries and the symptoms of concussion in hockey injuries [Steilen et al. 2014]
  - WAD and post-concussion injuries result in development of chronic neck pain

Cervicogenic Assessment - Joints

• Joint Play Assessment
  - Upper Cervical Joint play
    - OA ventral/dorsal and lateral glides
    - OA coupled motion
    - AA rotation
  - Cervical Flexion-Rotation Test
  - Manual assessment rotation about the dome

Cervicogenic Assessment - Strength

• Cervical Extensor Endurance Test (CEET)
  - Accuracy of the CEET is still debatable, but has “very good” inter-rater reliability
    - \( k = 0.809, \text{SE of kapp}=0.109, 95\% CI \)
    - Sebastian et al, Journal of Bodywork and Movement Therapies April 2014
  - Patient prone, head and neck past the edge of the table with cervico-thoracic junction stabilized and attempts to sustain a chin tuck position in neutral for 20 seconds
  - Deep neck extensor weakness
    - Increased “chin length” as the neck extends observed on an inclinometer
    - Indicates dominance of the superficial extensors
  - Deep and superficial weakness
    - Presence of neck flexion due to inability to hold head up

Cervicogenic Assesment - Strength

• The CranioCervical Flexion Test
  - Uses a stabilizer (pressure cuff) placed under neck used to instigate flexion
  - Assess two things
    - The strategy to perform upper cervical flexion
    - Isometric endurance of deep cervical flexors

• Neck Flexor Endurance Test
  - Uses observation of neck folds and placement of therapists hand under the occiput to assess cervical flexors
  - Involves superficial cervical muscles but still assessing control of deep cervical flexors
  - Norms
    - Without neck pain = 18.65 seconds
    - With neck pain = 24.1 seconds

Cervico-Vestibular Rehabilitation

• Median time since concussion (50 days)
• Control group (n = 14):
  - Non-provocative range of motion exercises, stretching and postural education
  - Experimental group (n = 15):
  - All above + cervical spine physiotherapy and vestibular rehabilitation

Cervicogenic Screen

• Screen for more severe issues (but understand the limitations of the testing)
  - Upper cervical instability
  - Vertebral artery
  - Cranial Nerve testing
• Screen for issues other than cervicogenic origin
  - VOMS – later in vestibular section
  - BPPV
  - TMD
  - Vision

• Make sure they don’t need more than just cervicogenic rehabilitation, refer if needed

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Cervicogenic Assessment – Proprioception

- Seated with crown of head 90 cm away from target
  - >4.5 cm of error is likely to be significant
- Variations of this test exist

Target by Rob Landel, PT, DPT, OCS

Cervicogenic Intervention

- Mobilization and Manipulations
  - Cervical
    - OA traction manipulation/mobilization
    - Occiput dorsal mobilization
    - Lower cervical facet distraction
    - Lower cervical facet glide
  - Thoracic
    - Bilateral Facet Distraction
    - AKA: Posture Mumps
    - Prone with mobilization wedge

Is It Really My Way or the Highway?

- 51 subjects with chronic neck pain (CNP)
- Parallel-group double blind randomized control trial
- 3 Groups
  - HVLA (Flynn and Cleland)
  - Mobs (oscillatory unilateral PAs)
  - SNAG (sustained natural apophyseal glide)
- Measured VAS, NDI, Global Rating of Change (GROC), and cervical ROM
- No significant differences between in satisfaction for all techniques leading to the interpretation
- No long-term difference between the application of HVLA, Mob, and SNAG in pain, disability, and cervical ROM for patients with CNP

Cervicogenic Intervention

- Soft tissue mobilization
  - Functional Massage and Manual Muscle Stretching
    - Suboccipitals
    - Cervical Paraspinals
    - Upper Traps
    - Levator
    - Scalenes

Cervicogenic Intervention

- Strengthening
  - Stabilizer Biofeedback Progression
  - Repeated performance for re-education
  - Longer holds for endurance training
  - Modified Cervical Isometrics
  - Molar Isometrics
  - “Pony Tail Pull-Ups”
  - Posterior Cervical Head Slides
  - NOT RETRACTING
  - Perform with UE movements and in different positions
  - Extensor Isometric Training with T-band
  - Add mirror/visual disturbances if needed

Cervicogenic Intervention

- Scapular Training
  - Levator and Upper Trapezius have direct attachments from spine to scapula
  - Deficiencies can be directly from these two or indirectly
  - Issues with these force-coupled partners can have a significant impact as well
  - Serratus
  - Rhomboids
  - Lower Trap
- Improved scapular position should reduce load on cervical spine as well as allow for improved ROM.
Cervicogenic Intervention

- Cervical Proprioception Training
  - Laser Feedback
    - Using joint position error test as an exercise
      - Eyes open, eyes closed with or without therapist manual guidance (tactile cuing)
    - Wall Clock
    - Wall Maze
    - Wall Drawing or Tracing
      - Different shapes
    - Joint position error test as an exercise
      - Eyes open, eyes closed with or without therapist guidance (tactile cuing)
  - Loss of imagination is your only limitation
  - Take caution to visual/vestibular concussion symptoms

Balance Training

- Static balance training from standard balance testing
  - Romberg
  - BESS
- Dynamic balance training
  - Reaching
  - Perturbations
  - Medicine ball
  - Rebounder
  - Obstacle course
  - Sport specific balance
- Pillows, foam pads, dyna disc, BOSU balls, trampolines, wobble boards
- DUAL TASK!

Vestibular Examination

- Common symptoms
  - Dizziness
  - Fogginess
  - Nausea
  - Detached
  - Anxiety
  - Overstimulation in complex environment
- Balance may or may not be affected
- Rule out BPPV – Dix Hallpike
- VOMS
  - May be able to indicate who needs specialized vestibular and vision therapy early in the recovery process which in turn may expedite their recovery (Collins et al 2014)

VOMS

A Brief Vestibular/Ocular Motor Screening (VOMS) Assessment

Vestibular/Ocular Motor Screening (VOMS) for Concussion

<table>
<thead>
<tr>
<th>Objective</th>
<th>Symmetry</th>
<th>Direction</th>
<th>Speed</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>Positive</td>
<td>Positive</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
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<td>Negative</td>
</tr>
</tbody>
</table>

3 VOMS items (VSR, VMS, NPC distance) resulted in 88% accuracy for identifying patients with concussion – Mucha et al 2014

Vestibular Assessment

- It’s important to note triggers – can help guide intervention
  - VSR
  - Balance Error Scoring System
  - Functional Gait Assessment
  - VOR
  - VOMS
  - King-Devick
  - Head thrust
  - Head shake
  - Gaze stability
  - Sensory Organization Test (SOT) if you got one

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Vestibular Intervention

Majority of concussion patients
• Habituation
  • Reduction in symptoms produced through repetitive exposure to movement
• Things to consider
  • What is the baseline of symptoms?
  • What is the acceptable increase in symptoms?
  • Appropriate rest?
  • How many times a day?

Progression of VORx1 exercise

Ocular Motor

• Symptoms
  • Frontally based headaches – eye strain
  • Fatigue
  • Distractibility
  • Pressure behind eyes
  • Difficulty focusing (blurred vision/double vision)
  • Difficulty with visually based classes
  • Difficulty reading / losing place
• Worse during school, better over the weekend
  • Poor academic and work performance
• Referral to neuro-optometrist or vision therapy provider may be warranted

Ocular Motor

• VOMS assists in screening for this
• Other things to look at
  • Resting Eye Alignment
  • Pupillary response to light
  • Not just the distance with the convergence test but what happens with the eyes
  • Insufficiency
  • Spasticity
• Convergence insufficiency can be managed by PT's specializing in vision therapy

Ocular Motor

• King-Devick Test
  • Screens for saccadic eye movements
  • Also attention, concentration, speech/language
  • Still should assess pursuits, vergence, and accommodation
Vision Therapy

- Remember when to refer out
- Convergence issues can be managed with
  - "Pencil Push-ups" are fine but
  - Brock String
  - 3 dot “Albee Card”

Cognitive-Fatigue

- Symptoms
  - Fatigue
  - Decreased energy levels
  - Non-specific headache
  - Sleep disruption
  - **Increase in symptoms towards the end of the day – school?**
  - **Difficulties with concentration**

- KEY - May perform optimally in the clinical setting but struggle within the classroom

Cognitive – Fatigue Intervention

- Reducing demands from both cognitive and physical perspective
- Regulate sleep
  - Consistent bed and wake time – including weekends
  - Sleep aids utilized when necessary
- Nutrition
  - Diet
  - Hydration
  - Monitor stress

- Think about this effect on return to learn later in presentation

SLP

- Can provide a comprehensive assessment of patient’s cognitive and communication skills.
- Working memory and executive functioning
  - Difficulty with:
    - Remembering
    - Word retrieval
    - Following directions
    - Conversing with peers

- Rehabilitation strategies for Prolonged Recovery in Pediatric and Adolescent Concussion Vidal er al Pediatric Annals 41:9 Sept 2012

SLP Intervention

- Verbal and non-verbal
- Listening
- Speaking
- Gesturing
- Reading
- Writing
- All domains of language
- Phonologic, morphologic, syntactic, semantic, and pragmatic
- What clinical trajectory could this help out with?
Anxiety/Mood - Psych

- Symptoms
  - Anxiety
  - Can’t stop thinking about it – effecting sleep
  - Feeling overwhelmed or hopeless
  - Emotional
  - Irritable
  - Inappropriate/impulsive behavior
  - Improvement in other areas (vestibular) can decrease the anxiety

Anxiety/Mood-Psych

- Start a supervised exertional protocol
  - May just need to feel like they are doing something about it
  - Physical activity – level 1 exertional program
  - Emotional release
  - Track progress to refocus their attention
  - Provide structure and a schedule
  - May have to refer for psych eval
  - Pharmaceutical intervention may be needed

Bigger picture

- Communication with schools
  - GO TEAM!!!
- School accommodations
- Testing/Studying
- Driving

There’s no “I” in Team... or is there?

The Team approach

- A multidisciplinary team is crucial to maximize student recovery
- Family/Friends Team
  - Student, parents/guardians, grandparents, brothers/sisters, peers, teammates
- Medical Team
  - Emergency department, primary care provider, psychologist, orthopedic physical therapist, vestibular physical therapist, speech language pathologist

The Team AT School

- School Academic Team
  - Teacher, school counselor, school psychologist, social worker, school nurse, school administrator, school physician
- School Physical Activity Team
  - Athletic trainer, coach, physical education teacher, athletic director, school nurse, school physician

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Communication is Key

- Communication between all "team members" is vital
- Needs to be within and between the medical and school teams
  - Appropriate monitoring
  - Appropriate accommodations
  - Appropriate follow-ups / referrals

Return to Play

- Exertional Therapy
  - Depending on state, within state location ($$), and programs may not be able to do this in our PT clinic.
    - Speed dial, my super top friends, etc

  - Return to play is great, however, if that is achieved is everything accomplished?
    - WKB February 10, 2014

Return to Play/Learn

Evaluation of the Zurich Guidelines and Exercise Testing for Return to Play in Adolescents Following Concussion
Scott R. Sherbar, MST, John S. Lundy, MS, John E. Battle, PhD, Sara J. Wiljes, B.S., C.M.D.
Journal of Sport Med 2014

- Zurich guidelines in combination with the Buffalo Concussion Treadmill Test is a safe and successful for return to play
- However, 35.5% of adolescent athletes experienced problems adjusting to the classroom following a concussion
- Side note – Computerized Neuropsychological Testing had no relationship with presence of school adjustment issues
  - Automated Neuropsychological Assessment Metrics (ANAM)
  - Immediate Post-concussion Assessment and Cognitive Test (ImPACT)

Return to Learn

- Difficulties include
  - Paying attention / concentrating
  - Learning new tasks
  - Remembering previously learned material
  - Taking longer to complete assignments/tasks
  - Organizing or transitioning between tasks
  - Handling stimulation school environments

Return to Learn

- Imperative that school officials recognize the need for academic or environmental adjustments:
  - IEP: Individualized Education Plans
  - 504 plan
  - Barriers
    - Inadequate training on concussion management is among the most significant barriers to effectively counseling patients on returning to school following concussion
    - Varied settings throughout the day (Noise sensitivity)
    - Lunchroom
    - Shop class
    - Band/chori
    - PE
    - Hallways

What’s our role?

- First understand what can is available for the students
  - Individual Education Plan (IEP)
  - 504 Plan
  - "special education"
  - Codes/classifies the student into 1 of 13 federally designated categories
  - Allows modification of regular education without penalty to the student
  - Provides for student not eligible for IEP but who requires accommodations based on the medical need
    - Documented by a physician and validation by the educational home

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What's our role?

- Communication with the school.
  - Writing letters
  - Phone calls
  - School PT, nurse, physician, trainer
- Assisting in discussions and providing recommendations for accommodations
  - Driving
  - Symptom monitoring throughout day
  - Class environment
  - Exam

School Accommodations

- Adjusting schedule
  - Rest periods
  - Substituting classes that provoke symptoms with study hall to reduce exposure
  - Allow late start or shortened school day
    - Helps catch up on sleep

School Accommodations

- Visual Symptoms
  - Light Sensitivity
    - Reduce brightness on screens
    - Allow student to wear hat/sunglasses
  - Audiotape books
  - Blurry vision
    - Change student's seat
  - Double vision
    - Eye patch

School Accommodations

- Noise Sensitivity
  - Have lunch in a quiet area with a friend
  - Limit or avoid "high volume" classes
  - Band, shop, choir, PE
  - Avoid noisy gyms and organized sport practices
  - Consider ear plugs / noise cancelling headphones
  - Early dismissal
    - Extra time to get between classes
    - Avoiding crowded hallways

School Accommodations

- Difficulty with concentration/remembering
  - Avoid testing/major projects during this time if possible
  - Extra time for test taking
  - 1 test per day
  - Oral test taking
EDUCATE, Educate, Educate!!!

- Parents to follow-up with their child after school
- Teachers follow-up with the student if not daily then weekly

- Take the initiative, students may not seek them out.

Building your Team

- Use your resources to find your team-mates
- Use your patient’s to get an in
  - Physician
  - School
    - Trainer, AD, Teachers, etc
- Be willing to “work” beyond 9-5

References

- bikepain.com (2015). A comprehensive clinical and manu...