mTBI

Concussion, Post Concussion Syndrome and mTBI
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"I'm searching for my keys."
Cognitive Issues
Ideally with Baseline
Studies that compare those with mTBI and orthopaedic controls found no difference on cognitive performance (Boake et al. 2005; Ponsford et al. 2011)
When reality doesn’t match expectations....

• If someone complains of persistent symptoms but there is no measurable cognitive issues it must be....
  – Anxiety
  – Depression
  – Stress
  – Perception of illness/injury

• In other words, it is not really brain injury
Problems with the research to date

• Still some confusion about definition of a concussion (or at least the scientific rigor to ensure diagnosis)
  – Much improved with use of SCAT2 and other instruments for acute assessment

• **Lots of confusion** about definition of persistent symptoms (PCS or mTBI) (see Boake 2005)
  – Symptoms based definitions are fraught with difficulty
Physiology of Concussion (Hovda et al.)

- Metabolic Cascade
- Extra cellular K+
- Increased glutamate
- **Reduced cerebral blood flow**
- Calcium channel blockers prevent reuptake of Ca2+
- Systemic changes that last up to 7 days
  - Long after symptoms subside
  - But about the same time it takes to return to baseline
Treatment of Concussion and Persistent Symptoms (PCS)

- Rest during the period of metabolic disruption helps
- After a few weeks rest is harmful
- Anti-depressants commonly prescribed
The Dark Side (Where the keys were lost?)

Physiologic characteristics of PCS (Signs)
Assessment of Physiology

Reminder:
Current return to play protocol involves graded exercise, and return to play is appropriate when the athlete can exercise to the level of their sport without exacerbation of symptoms.

Assessment of physiology requires stress (i.e. exertion). Just as we assess cardiovascular function, we assess the physiologic effects of concussion on a treadmill.

Treadmill test provides a more systematic approach to RTP assessment.
Signs of Post concussion disorder

- Resting heart rate is lower
- Rate of heart rate increase during exercise is slightly higher
- Perceived exertion is higher
Signs of PCD

- Altered autonomic control of cerebral blood flow
- Altered control of ANS
  - Increased sympathetic control
  - Decreased parasympathetic control
- Altered Blood Brain Barrier
  - Apo A1 in serum
A Definition of PCS (mTBI) based on physiology

- History of trauma causing “significant cerebral concussion”
- Three or more signs or symptoms lasting at least three weeks
- Exacerbation of symptoms with “provocative exercise”

This definition combines the strengths of the symptom based approach but yet recognizes the physiologic aspects of PCS (consistent with the Zurich consensus conference)
Buffalo Concussion Treadmill Test

- Standardized procedure to reveal signs of PCS
- Reliable (test retest and inter-rater)
- Safe
- Predicted uneventful return to play (100%)
Physical exam

- Risk for provocative exercise testing
- Brief assessment of possible cervical strain
- Assess balance and coordination
- Assess ocular motor system
- Orthostatic vital signs
Clinical Aspects of Assessment

• We assess HR using a polar monitor that provides the average HR for each minute
• We assess BP
• We record Perceived exertion (using the Borg RPE Scale)
• Observe for changes

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Symptom Exacerbation

• Symptom exacerbation usually represented by a feeling that one’s head is full
  – “My hat just got too tight”
• Only occasionally is there exacerbation of at-rest symptoms
• Must be distinguished from symptoms of exercise
  – Occur at earlier RPE
  – More obvious signs of distress

Tino PCS
Nancy Headache
Charles PCS
Differential Diagnosis

• PCS is represented by symptoms + symptom exacerbation (with exertion)

• Cervical strain usually produces headache and/or dizziness
  • Headache usually gets **better** during the exercise
  • Confirm with neck exam

• If not PCS or Cervical strain then:
  – Anxiety reaction; Migraine; Vestibular issues; Ocular issues
  – Baker paper/current data
Develop a treatment plan for PCS

- 80 to 90 percent of threshold (HR associated with symptom exacerbation)
- 20 minutes per day
- Start cautiously and indicate to not exercise if symptoms are worse than normal or if symptoms get worse during exercise
- Establish an appropriate follow up plan
  - Re-assessment not always possible but with good communication we can determine when the HR limits can be increased (every two weeks)
  - Adapt the protocol to suit the progress noted
Prognostic factors

- Athletes follow protocol better and improve much faster
- Recent injuries recover faster than long term injuries (e.g. more than one year)
- Some issues resolve easier (attention, memory) than others (balance, visual disturbances). Headache outcome highly variable.
- Younger patients recover faster than older patients
Concluding treatment

• Once the individual can exercise to voluntary exhaustion without symptom exacerbation then “physiologically recovered”
  – May still have visual disturbance which does not respond to exercise
  – Expect no change in neuropsychological test results

• Advice on RTP based on history (e.g. previous number of concussions) and other signs and symptoms
Research Findings

• Provocative exercise test is safe and reliable
• We believe the provocative exercise test is a valid approach to evaluation of PCS
• Graded exercise program speeds recovery
• We believe that some individuals with concussion have ongoing issues with autoregulation of cerebral blood flow and have collected some evidence that supports this hypothesis
Symptom Reduction

12 Subjects

All returned to sport/work

All eventually improved in symptoms although tremendous range in time to recover

Long Term Follow Up

- Followed 91 consecutive pts
- 65 had exacerbation of symptoms (PCS)
- 26 did not have exacerbation of symptoms
  - 14 (52%) Cervicalgia
  - 5 (18%) Migraine
  - 6 (22%) Depression
  - 1 (4%) PTSD

- One year follow up:
  - PCS 77% full function
  - Other 64% full function
  - 5 of 6 who refused to exercise not return to full function
Above: Composite of metabolic activity associated with simple math questions in PCS pre-Rx. Wide range of activity is unfocused and inefficient.

Below: Composite reveals efficient and focused attention to math questions in PCS post-Rx. Similar to non-injured controls.
What this research tells us...

Groups
- PCS (treated with graded exercise)
- PCS (treated with stretching)
- Normals (no history of concussion)

Outcomes
- Performance on the cognitive task: no difference between groups and no difference between time points
- PCS subjects show much greater metabolic activity to achieve the same function
- PCS patients had decreased activity in posterior cingulate and cerebellum compared to normals during the task
- PCS patients with exercise were indistinguishable from normals after treatment
mTBI represents physiologic disruption

- mTBI is diagnosable using signs as well as symptoms
- Perhaps best viewed as a medical problem (vs a neuropsychological problem)

- mTBI is often misdiagnosed
  - More than 50%
  - No wonder cognitive measures can’t predict
  - Cervicogenic headache and dizziness the most common alternative
Thank You