

Assessment and Treatment of Refractory Post Concussion Syndrome

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Post Concussion Syndrome

- 90-95% of people recover from a concussion with no consequences (7-10 days)
- Some small percentage (5%?) will have symptoms that persist. This is referred to as post concussion syndrome (PCS)
- There is no known cause for persistent symptoms
- There is no evidence based treatment for PCS (although rest and anti-depressants is the most common)

Colleagues

- Karl Kozlowski PhD ATC
- David Pendergast EdD
- John Baker PhD
- Leonard Epstein PhD
- Les Bisson MD
- Scott Dinse PT ATC

Concussion: a Systemic Physiologic Injury

Leddy et al Neurorehabilitation 2007

- Supported by **laboratory, fMRI, clinical evidence.**
- Autonomic Nervous System imbalance → excess sympathetic NS activation (King 1997; Gall BJSM 2004; Gall MSSE 2004).
- TBI: release of pro-inflammatory cytokines, e.g., c-reactive protein (Dewitt 2003).
- Altered fMRI cerebral blood flow volume and distribution in acutely concussed (McAllister 2001) and in those with PCS (Chen et al 2004).

Consensus Statement on Concussion in Sport, Zurich 2008

Graduated Return to Play Protocol

1. No activity until asymptomatic
2. Light aerobic exercise
3. Sport-specific exercise
4. Non-contact training drills
5. Full contact practice
6. Return to play

Issues with RTP Guidelines For Athletes with PCS

- **Require athlete to be asymptomatic before proceeding**
 - Problem is that most individuals without concussion are not asymptomatic at rest
 - Individuals with prolonged symptoms become focused on their symptoms and may not recognize a state of “asymptomatic”
- **Encourages deconditioning due to prolonged rest period for those with PCS**
 - All of the evidence with animal research supports the notion that concussed athletes should avoid exercise for the first two to three weeks after the injury
 - However, the evidence suggests that exercise after the three week period assists in recovery of the animal with concussion

Positive aspects of RTP Guidelines For Athletes with PCS

- **Exercise to voluntary exhaustion without exacerbation of symptoms is the key element of the RTP guidelines**
- This requirement recognizes that PCS represents a problem of physiologic imbalance
 - The guidelines are consistent with the growing body of research that demonstrates physiologic imbalance in those with PCS

Post concussion syndrome

- DSM IV: history of trauma causing “significant cerebral concussion”
 - Cognitive deficit on test(s)
 - Three or more symptoms > 3 months
 - Interference with function
 - Exclusion of other diagnoses which account for symptoms
- WHO: history of trauma
 - Three or more symptoms > 1 month
- Boake et al. 2005: little concordance between these two criteria
- Serious weaknesses in a symptoms based approach to diagnosis

(Our) Definition of PCS based on perception as a problem of 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)

Provocative exercise testing

- We have assessed 60 individuals using the exercise tests we will demonstrate today
- The testing procedures were consistently without incident
- Test-retest reliability over a period of three weeks with a sample of 21 Ss indicate adequate TRT reliability (**ICC=0.79**)
- Inter-rater reliability using 10 videos and 32 raters with various medical backgrounds indicate adequate IR reliability (**ICC=0.90**)

Physiology based assessment of PCS

- History of trauma causing “significant cerebral concussion”
1. Hear the story but remember it may be months since the injury occurred
 2. Is there acceleration deceleration of the head? Is there a possible whiplash effect on the neck?
 3. Is there evidence of amnesia/confusion?
 4. Is there a history of concussion?
 5. Medical history and assessment of risk for provocative exercise testing

Anthony Injury

Symptoms and Symptom Timing

- Symptoms at the time of the injury
- Symptoms during the first few days after the injury
- Symptoms currently reported
 - We use a structured interview/questionnaire that accounts for both the WHO criteria and the DSM IV criteria
- History of symptoms prior to the injury (e.g. Migraine)

Physical exam

- Risk for provocative exercise testing
- Brief assessment of possible cervical strain
- Assess balance and coordination
- Orthostatic vital signs

Provocative exercise testing

- Balke Protocol:
- Set the treadmill speed at 3.4 mph with a 0% grade. Continue at this grade and speed for one minute. At the start of the second minute, increase the grade to 2%, maintaining the speed. At the beginning of the third minute, increase the grade an additional 1% and continue to increase it 1% for every minute thereafter until the grade becomes too strenuous or the subject can no longer perform. Record the final time, which is the last full minute the subject was able to perform.

Introducing the procedure to the patient

- Patient needs to be relaxed and an explanation of the procedure helps
- Critical that the patient inform the tester of any changes in symptoms
 - Athletes are used to pushing through difficulties and thus are not necessarily attentive to symptom changes
- Have a second person available in case patient has difficulty with balance

Randy Introduction

Keeping record

- We assess HR using a polar monitor that provides the average HR for each minute
- We assess BP but find it generally not as reliable as HR
- We record HR, BP and Perceived exertion (using the Borg RPE Scale)

6	no exertion at all
7	extremely light
8	
9	very light
10	
11	light
12	
13	somewhat hard
14	
15	hard (heavy)
16	
17	very hard
18	
19	extremely hard
20	maximal exertion

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 the 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
 - Refer for assessment

Laura Headache

Develop a treatment plan for PCS

- 80 percent of threshold (HR associated with symptom exacerbation)
- 15 to 20 minutes per day (with someone else present)
- 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

Angela Physical

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

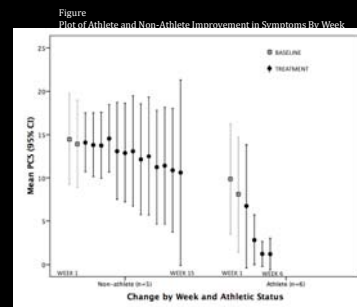
- Once the individual can exercise to voluntary exhaustion without symptom exacerbation then “physiologically recovered”
 - May still have visual disturbance which does not respond to exercise
 - Expect no change in neuropsychological test results
- Advice on RTP based on history (e.g. previous number of concussions) and other signs and symptoms

Angela Recovery
Michael Recovery

Research Findings

- Provocative exercise test is safe and reliable
- We believe the provocative exercise test is a valid approach to evaluation of PCS
- 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



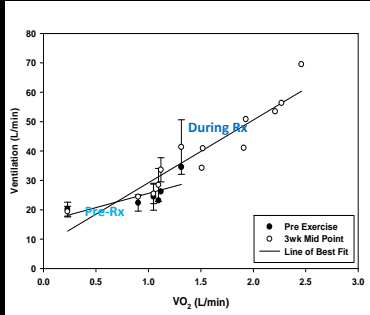
Leddy et al. (2010) [Clinical Journal of Sports Medicine](#)

12 Subjects

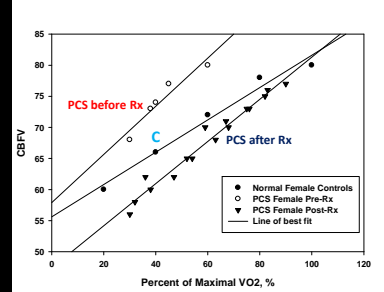
All returned to sport/work

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

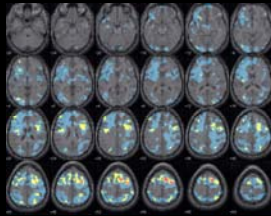
Minute ventilation (V_E) with increasing oxygen consumption (VO_2) in PCS subjects (n= 3) before and during Exercise Rx.



Cerebral Blood Flow Before and after Exercise Rx (N = 2)

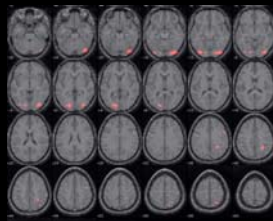


Math-SRT PCS (N=3)



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.



Future Directions

- Research
 - Intent to Treat analysis
 - Finish study on fMRI
 - Complete study of CBF
- Education
 - Develop education materials for teens, teachers
 - Develop CE program for health care professionals

