In-Office Evaluation of Sports Concussion: Components of Assessment, Treatment and Rehabilitation

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UPMC Sports Concussion Program
Disclosure Statement

Micky Collins, PhD is a Co-Founder and Board Member of ImPACT Applications, a computerized neurocognitive test battery designed to assess sports concussion and Mild Traumatic Brain Injury.
Lecture Goals

• Present a clinical care model for the management, treatment and rehabilitation of sports-related mTBI
• Discuss role of clinical interview, vestibular-ocular screening and computerized neurocognitive testing in the assessment of sports mTBI
• Present data correlating neurocognitive and vestibular-ocular outcomes following sports mTBI
• Present a case study regarding treatment of post-concussion syndrome in a professional athlete
Case Example
Major League Baseball - Catcher 2012
Case Example: MLB Catcher

27 year-old-MLB player (Catcher)
- Medical history-remarkable for four prior concussions
  - 2003-Beaned by fastball-Reported symptoms for 7 days then RTP
  - 2005-Beaned by fastball-Symptoms for 5 days then RTP
  - 2008-Foul tip to facemask while catching-Symptoms 15 days then RTP
  - 2010-Foul tip to facemask while catching-Symptoms 30 days then RTP

- 2011- Tendency for foul tips to produce “dizziness, vision changes, headaches, foggy”-never taken out of play
  - “Idiopathic” issues with vision for 6 weeks-visited opthamologist-no formal diagnosis or treatment recommendations

- History of motion sensitivity (car sickness) as child
- No other medical or psychiatric history
- Academic history-Did very well in limited school-no history of LD or ADD
  - Drafted at Age 16 from Venezuela

Concussion sustained 03/11/12
March 11, 2012

- Foul tip to facemask while catching
- Acute symptoms of dizziness, bilateral blurred vision, feeling slow and detached
- Symptoms worsened over next three innings, told ATC and removed from game
- Sent to Emergency Room-CT Scan of head, X-ray of neck unremarkable

Rested for 3 weeks with “minimal improvement”

- Continue to reported headaches (8 hours per day; 6/10 severity), moderate levels of photosensitivity, phonophobia, fatigue, fogginess, cognitive deficits, significant sleep concerns, emotional “flatness”

Referred to UPMC on 04/04/12
(3.5 weeks post injury)
The UPMC Sports Concussion Program

Department of Orthopaedic Surgery
Comprehensive Assessment and Treatment Approach

Concussion

Neuro-cognitive

Vestibular

Ocular-Motor

Physical Exertion

Symptoms
The UPMC Sports Concussion Program

Over 18,000 Patient Visits Per Year
### UPMC Typical Evaluation

**✓ Clinical Interview**

**✓ Vestibular-Ocular Screening**

**✓ Computerized Neurocognitive Testing**

<table>
<thead>
<tr>
<th>Same day patient feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Severity of Injury?</td>
</tr>
<tr>
<td>- Prognosis for Recovery?</td>
</tr>
<tr>
<td>- Neuroimaging indicated?</td>
</tr>
<tr>
<td>- PMR/Vestibular/Optometry referral?</td>
</tr>
<tr>
<td>- Level/type of Physical Exertion Allowed?</td>
</tr>
<tr>
<td>- Level of Cognitive Exertion Allowed?</td>
</tr>
<tr>
<td>- Academic Accommodations?</td>
</tr>
<tr>
<td>- Return to Play?</td>
</tr>
</tbody>
</table>

Communication to ATC, Team Physician, Referring Physician, etc.
In-Office Evaluation

- Clinical Interview
- Vestibular Screening
- Neurocognitive Testing
Factor Analysis, Post-Concussion Symptom Scale

N=1,438
High School & College Athletes at 1-7 Days Post-Concussion

Kontos, Elbin, Schatz, Covassin, Henry, Pardini, Collins; *AJSM*, 2012
Clinical Interview:
What Risk Factors/Symptom Profiles Best Predict More Complicated Recovery?
<table>
<thead>
<tr>
<th>Established (?) Constitutional Risk Factors For More Complicated Recovery</th>
</tr>
</thead>
</table>
- Pellman, Lovell et al. *Neurosurgery*, 2006 |
| **Learning Disability** | - Collins, Lovell et al, *JAMA*, 1999  
- Elbin et al., Data under review |
- Iverson et al, *CJSM*, 2004  
- Covassain et al, *CJSM*, 2009 |
- Lau, Collins, Lovell et al. *AJSM* 2012  
- Henry, Burkhart, Elbin Data in preparation |
# Sensitivity and Specificity of Subacute Outcome Variables in Classifying Short (<7 days) versus Protracted (>30 Days) Recovery from Sports Concussion

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive Predictive Value</th>
<th>Negative Predictive Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCSS Symptom Total Score</td>
<td>40.81%</td>
<td>70.31%</td>
<td>62.5%</td>
<td>61.33%</td>
</tr>
<tr>
<td>PCSS Symptom Clusters</td>
<td>42.91%</td>
<td>73.2%</td>
<td>63.9%</td>
<td>62.86%</td>
</tr>
<tr>
<td>Neurocognitive Composite Scores</td>
<td>53.20%</td>
<td>75.44%</td>
<td>64.10%</td>
<td>66.15%</td>
</tr>
<tr>
<td>Combined Migraine Symptoms and Neurocognitive Composite Scores</td>
<td>65.22%</td>
<td>80.36%</td>
<td>73.17%</td>
<td>73.8%</td>
</tr>
</tbody>
</table>


Study examined ability of variables, at day 2 post-injury, to predict short (<7 day) versus protracted (>30 days) recovery in a sample (N = 108) male concussed football players.
Which On-Field Symptoms Predict Protracted Recovery (i.e. Post-Concussion Syndrome)?

Which On-Field Markers/Symptoms Predict **3 or More Week** Recovery from MTBI In High School Football Players

<table>
<thead>
<tr>
<th>On-Field Marker</th>
<th>N</th>
<th>Chi²</th>
<th>P</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posttraumatic Amnesia</td>
<td>92</td>
<td>1.29</td>
<td>0.257</td>
<td>1.721</td>
<td>0.67-4.42</td>
</tr>
<tr>
<td>Retrograde Amnesia</td>
<td>97</td>
<td>.120</td>
<td>0.729</td>
<td>1.179</td>
<td>0.46-3.00</td>
</tr>
<tr>
<td>Confusion</td>
<td>98</td>
<td>.114</td>
<td>0.736</td>
<td>1.164</td>
<td>0.48-2.82</td>
</tr>
<tr>
<td>LOC</td>
<td>95</td>
<td>2.73</td>
<td>0.100</td>
<td>0.284</td>
<td>0.06-1.37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>On-Field Symptom</th>
<th>N</th>
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<th>P</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dizziness**</td>
<td>98</td>
<td>6.97</td>
<td>0.008</td>
<td>6.422</td>
<td><strong>1.39-29.7</strong></td>
</tr>
<tr>
<td>Headache</td>
<td>98</td>
<td>0.64</td>
<td>0.43</td>
<td>2.422</td>
<td>0.26-22.4</td>
</tr>
<tr>
<td>Sensitivity LT/Noise</td>
<td>98</td>
<td>1.19</td>
<td>0.28</td>
<td>1.580</td>
<td>0.70-3.63</td>
</tr>
<tr>
<td>Visual Problems</td>
<td>97</td>
<td>0.62</td>
<td>0.43</td>
<td>1.400</td>
<td>0.61-3.22</td>
</tr>
<tr>
<td>Fatigue</td>
<td>97</td>
<td>0.04</td>
<td>0.85</td>
<td>1.080</td>
<td>0.48-2.47</td>
</tr>
<tr>
<td>Balance Problems</td>
<td>98</td>
<td>0.28</td>
<td>0.59</td>
<td>0.800</td>
<td>0.35-1.83</td>
</tr>
<tr>
<td>Personality Change</td>
<td>8</td>
<td>0.86</td>
<td>0.35</td>
<td>0.630</td>
<td><strong>.023-1.69</strong></td>
</tr>
<tr>
<td>Vomiting</td>
<td>97</td>
<td>0.68</td>
<td>0.41</td>
<td>0.600</td>
<td>0.18-2.04</td>
</tr>
</tbody>
</table>

The total sample was 107. Due to the normal difficulties with collecting on-field markers, there were varying degrees of missing data. The number of subjects who had each coded ranged from 92-98. The N column represents the number of subjects for whom data were available for each category. Markers of injury are not mutually exclusive.  

*Lau, Kontos, Collins, Lovell, AJSM 2011*
Which Symptoms at 3 Days Post Injury Best Predict Protracted Recovery?

Lau B, Lovell MR, Collins MW; Pardini J; CJS 2009 (3):216-21
Expressed as Effect Sizes (Cohen’s D). Only includes symptoms with large (greater than .80) effect sizes. Sample is composed of 108 male HS football athletes.

Lau, Lovell, Collins et al. 2009, CJSN
Clinical Interview Summary

- Outcomes are highly variable
- Vestibular-related symptoms of on-field dizziness and sub-acute fogginess best predict more protracted recoveries
- Migraine-type symptoms (and potentially preexisting history of migraine) may place individuals at increased risk of injury and longer recovery
- Diathesis-Stress model for clinical outcomes
- Important to understand consistency in symptom clusters, examination findings and evolving clinical trajectory pathways
Concussion Clinical Trajectories

- Vestibular
- Ocular
- Anxiety/Mood
- Cervical
- Cognitive
- Post-Traumatic Migraine
Using Concussion Clinical Trajectories to Inform Targeted Treatment Pathways

Risk Factors: Previous Concussions, Migraine, LD/ADHD, Sex, Age, Motion sensitivity, Ocular Hx?

Concussion Clinical Trajectories: Vestibular, Ocular, Cognitive, Migraine, Anxiety/Mood, Cervical

Treatment and Rehab Pathways
In-Office Evaluation

- Clinical Interview
- Vestibular-Ocular Screening
- Neurocognitive Testing
Why care about the vestibular system?
Subjective Complaints Related to Vestibular-Ocular Dysfunction: Looking Beyond Balance

- Dizziness, Fogginess, Feeling detached
- Motion discomfort, Nausea
- Difficulty in busy visual environments
- Anxiety, Increased emotionality, Intolerance to busy places
- Fatigue, Difficulty focusing, Blurred vision, Difficulty with Math/Reading
- Impaired balance
Vestibular-Ocular Screening

- **Ocular-Motor:**
  - “H-Test”- Smooth Pursuits
  - Saccades-Vertical and Horizontal
    - Any dizziness, blurriness, over/under shoots?

- **Vestibular-Ocular:**
  - Gaze Stability (focus on stationary object while moving head up and down/side to side)-Examine Horizontal and Vertical Planes
    - Any observable nystagmus, provocative dizziness/blurriness, slowed movements?
  - Optokinetic Sensitivity
  - Ocular Convergence and Accommodation
    - In high school/college aged athletes, near point < 6 cm

- **Balance Examination**
  - Romberg, Compliant Foam-eyes open/eyes closed
## Vestibular-Ocular Screening Form

<table>
<thead>
<tr>
<th></th>
<th>Norm</th>
<th>Abn</th>
<th>HA 0-10</th>
<th>Dizzy 0-10</th>
<th>Nausea 0-10</th>
<th>Foggy 0-10</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smooth Pursuits/&quot;H&quot; Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saccades – Horizontal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saccades – Vertical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaze Stability (VOR) –</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaze Stability (VOR) - Vertical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response to Optokinetic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convergence (Near Point)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Near Point in cm)</td>
<td>Measure 1:</td>
<td>Measure 2:</td>
<td>Measure 3:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accommodation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Distance in cm)</td>
<td>Right:</td>
<td>Left:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mucha, Troutman, Collins, French, Burkhart, Henry 2013
Examining Prevalence of Vestibular-Ocular Dysfunction following Sports Concussion

Collins, Mucha, Troutman, Elbin, French, Henry, Burkhart, Kontos
Data in preparation for publication
Study Overview

• Purpose: To evaluate the prevalence of vestibular-ocular dysfunction in concussed athletes and ability of findings to predict concussion diagnosis during in-office evaluation of concussion

• Participants
  – 89 patients (14.93 years, SD = 1.78); Range (12 – 21) years
  – *Seen at 6.55 (SD = 4.63) days of injury*; Range (1 – 20) days
  – 62 males; 27 females

• 78 patients diagnosed w/concussion

• 11 patients no diagnosed concussion (controls)

• All patients underwent vestibular-ocular screening as part of clinical evaluation (in addition to clinical interview/computerized neurocognitive testing)
Prevalence of Vestibular-Ocular Abnormalities for Concussion Group (N = 78)-Mean = 7 days post injury

<table>
<thead>
<tr>
<th></th>
<th>Abnormal (Abnormalities present or provocative for symptoms)</th>
<th>Normal (No abnormalities present; no symptoms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pursuits (H-TEST)</td>
<td>77% (60)</td>
<td>23% (18)</td>
</tr>
<tr>
<td>Saccades (Horizontal/Vertical)</td>
<td>90% (69)</td>
<td>10% (8)</td>
</tr>
<tr>
<td>VOR Gaze Stability (Horizontal/Vertical)</td>
<td>92% (71)</td>
<td>8% (6)</td>
</tr>
<tr>
<td>Convergence Insufficiency (&gt;7cm)</td>
<td>53% (38)</td>
<td>47% (34)</td>
</tr>
<tr>
<td>Optokinetic Sensitivity</td>
<td>58% (45)</td>
<td>42% (32)</td>
</tr>
</tbody>
</table>
Vestibular-Ocular Abnormalities as Predictors of Concussion vs. No Concussion

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wald $\chi^2$</th>
<th>OR</th>
<th>p</th>
<th>95% CI for OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pursuits (H-TEST)</td>
<td>0.13</td>
<td>1.35</td>
<td>.72</td>
<td>0.27-6.82</td>
</tr>
<tr>
<td>Saccades (Horizontal/Vertical)</td>
<td>0.02</td>
<td>1.16</td>
<td>.89</td>
<td>0.13-10.28</td>
</tr>
<tr>
<td>VOR Gaze Stability (Horizontal/Vertical)</td>
<td>0.92</td>
<td>1.16</td>
<td>.34</td>
<td>1.06 – 1.26</td>
</tr>
<tr>
<td>Convergence Insufficiency</td>
<td>3.28</td>
<td>4.5</td>
<td>.07</td>
<td>0.80-22.22</td>
</tr>
<tr>
<td>Optokinetic Sensitivity</td>
<td>3.78</td>
<td>4.47</td>
<td>.05</td>
<td>0.89-22.53</td>
</tr>
</tbody>
</table>
In-Office Evaluation

- Clinical Interview
- Vestibular-Ocular Screening
- Computerized Neurocognitive Testing
Computer-Based Neurocognitive Testing

CURRENTLY AVAILABLE PROGRAMS:

- Cogsport (Axon)
- Headminders (CRI)
- ANAM
- CNS Vital Signs
- ImPACT

Extensive research since 2001
<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample Size</th>
<th>Population</th>
<th>Tests Utilized</th>
<th>Total Days Cognitive Resolution</th>
<th>Total Days Symptom Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lovell et al. 2005</td>
<td>95</td>
<td>Pro (NFL)</td>
<td>Paper and Pencil NP</td>
<td>1 day</td>
<td>1 day</td>
</tr>
<tr>
<td>McCrea et al. 2003</td>
<td>94</td>
<td>College</td>
<td>SAC</td>
<td>&lt;1 Day</td>
<td>7 days</td>
</tr>
<tr>
<td>McCrea et al. 2003</td>
<td>94</td>
<td>College</td>
<td>Paper and Pencil NP</td>
<td>5-7 days</td>
<td>7 days</td>
</tr>
<tr>
<td>Echemendia 2001</td>
<td>29</td>
<td>College</td>
<td>Paper and Pencil NP</td>
<td>3 days</td>
<td>3 days</td>
</tr>
<tr>
<td>Guskiewicz et al. 2003</td>
<td>94</td>
<td>College</td>
<td>Balance BESS</td>
<td>3-5 Days</td>
<td>7 Days</td>
</tr>
<tr>
<td>Bleiberg et al. 2005</td>
<td>64</td>
<td>College</td>
<td>Computer NP (ANAM)</td>
<td>3-7 days</td>
<td>Did Not Evaluate</td>
</tr>
<tr>
<td>Iverson et al. 2006</td>
<td>30</td>
<td>High School</td>
<td>Computer NP (ImPACT)</td>
<td>10 days</td>
<td>7 Days</td>
</tr>
<tr>
<td>McClincy et al. 2006</td>
<td>104</td>
<td>High School</td>
<td>Computer NP (ImPACT)</td>
<td>14 days</td>
<td>7-10 Days</td>
</tr>
<tr>
<td>Lovell, Collins et al. 2008</td>
<td>208</td>
<td>High School</td>
<td>Computer NP (ImPACT)</td>
<td>26 days</td>
<td>17 Days</td>
</tr>
<tr>
<td>Covassin et al 2011</td>
<td>72</td>
<td>High School</td>
<td>Computer NP (ImPACT)</td>
<td>21 days</td>
<td>7 Days</td>
</tr>
<tr>
<td>Maugans et al 2011</td>
<td>12</td>
<td>Ages 11-15</td>
<td>Computer NP (ImPACT)</td>
<td>30 days</td>
<td>14 Days</td>
</tr>
</tbody>
</table>
Sensitivity and Specificity of Computerized Neurocognitive Testing

Schatz P, Sandel N. Sensitivity and Specificity of the online version of ImPACT in high school and collegiate athletes. American Journal of Sports Medicine, -Epub ahead of print.

Two Athlete Groups Examined

**Study 1 (Concussed symptomatic athletes)**

- 162 athletes
  - 81 concussed athletes (diagnosed by ATC/Physician)
  - 81 carefully matched controls (non-concussed) matched on specific basis of gender, sport, concussion history, absence of LD/ADD
- Discriminate Function Analysis on subscale scores; no clinician input
- Testing completed within 3 days post injury
- Sensitivity/Specificity of neurocognitive testing determined
Sensitivity and Specificity of Computerized Neurocognitive Testing

Schatz P, Sandel N. Sensitivity and Specificity of the online version of ImPACT in high school and collegiate athletes. American Journal of Sports Medicine, Epub ahead of print.

**Study 1 (Concussed symptomatic athletes)**

**Sensitivity (91.4%)**
(Probability that that a concussion is present when test is positive)

**Specificity (69.1%)**
(Probability that a concussion is not present when test is negative)
Sensitivity and Specificity of Computerized Neurocognitive Testing

Schatz P, Sandel N. Sensitivity and Specificity of the online version of ImPACT in high school and collegiate athletes. American Journal of Sports Medicine, Epub ahead of print.

**Study 2 (Asymptomatic concussed athletes)**

- 74 Athletes
  - 37 athletes diagnosed with on-field concussion by ATC/physician, seen within 3 days of injury, and symptom score of 0
  - 37 carefully matched controls (non-concussed) matched on specific basis of gender, sport, concussion history, absence of LD/ADD
- Discriminate Function Analysis on Subscale scores; no clinician input
- Testing completed within 3 days post injury
- Sensitivity/Specificity of Computerized Neurocognitive Testing determined
Sensitivity and Specificity of Computerized Neurocognitive Testing

*Schatz P, Sandel N. Sensitivity and Specificity of the online version of ImPACT in high school and collegiate athletes. American Journal of Sports Medicine, Epub ahead of print.*

**Study 2 (Asymptomatic concussed athletes)**

**Sensitivity (94.6%)**
(Probability that that a concussion is present when test is positive)

**Specificity (97.3%)**
(Probability that a concussion is not present when test is negative)
Study Summary…

“The current results demonstrate that computerized neurocognitive testing is a useful, valid tool as part of a comprehensive post-concussion evaluation. Regardless of whether athletes are candid regarding the presence of post-concussion symptoms, performance on neurocognitive testing can identify neurocognitive deficits with 91-95% sensitivity.”
Determination of Neurocognitive Cutoff Scores that Predict Protracted Recovery (at 2 days post injury)

Lau B, Collins MW, Lovell MR

*Neurosurgery* 2012; Feb 70(2):371-79.
Cutoff Values of Computerized Neurocognitive Scores at 2 Days Post Injury That Predict Protracted Recovery

<table>
<thead>
<tr>
<th>Neurocognitive Domain</th>
<th>75% Sensitivity</th>
<th>80% Sensitivity</th>
<th>85% Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal Memory</td>
<td>66.5</td>
<td>64.5</td>
<td>60.5</td>
</tr>
<tr>
<td>Visual Memory</td>
<td>48</td>
<td>46</td>
<td>44.5</td>
</tr>
<tr>
<td>Processing Speed</td>
<td>24.5</td>
<td>23.5</td>
<td>22.5</td>
</tr>
<tr>
<td>Reaction Time</td>
<td>0.72</td>
<td>0.78</td>
<td>0.86</td>
</tr>
</tbody>
</table>

Sensitivity is defined as the ability of the cutoff to accurately identify *protracted* recovery (>14 days; Mean = 1 month) in a concussed athlete.

Vestibular-Ocular Impairment as Predictors of at Least One Neurocognitive Cut-off; N = 78 Concussed Athletes

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<td>Saccades (Horizontal/Vertical)</td>
<td>0.88</td>
<td>0.46</td>
<td>.35</td>
<td>0.09-2.38</td>
</tr>
<tr>
<td>VOR Gaze Stability (Horizontal/Vertical)</td>
<td>1.09</td>
<td>3.06</td>
<td>.30</td>
<td>0.34 – 27.48</td>
</tr>
<tr>
<td>Convergence</td>
<td>4.27</td>
<td>2.67</td>
<td>.04</td>
<td>1.04-6.85</td>
</tr>
<tr>
<td>Optokinetic Sensitivity</td>
<td>5.69</td>
<td>5.50</td>
<td>.02</td>
<td>1.26-23.94</td>
</tr>
</tbody>
</table>
Relationship Between Near Point Convergence and Computerized Neurocognitive Test Results in Protracted Recovery from Sports Concussion

Elbin, Kontos, Collins, French, Henry et al, Data in Preparation for Publication
Study Overview

• Purpose: To examine measurement of near-point convergence in relation to computerized neurocognitive performance and symptoms following sport-related concussion

• Participants
  – 48 athletes with a sport-related concussion
    • Tested 21 days-3 months post-injury
    • *Mean = 67 days post injury*
  – 28 males, 20 females
  – Average age= 15.21 (3.12), range= 11-23 years

• Measures
  – Near Point of Convergence
  – Computerized Neurocognitive Test Scores
  – Symptom Report (PCSS)
Verbal Memory and Reaction Time Scores for Normal and Abnormal Convergence Groups

- **Verbal Memory**
  - Normal Convergence: 86%
  - Abnormal Convergence: 80%
  - *p = .05

- **Reaction Time**
  - Normal Convergence: 0.59 sec
  - Abnormal Convergence: 0.67 sec
  - *p = .05

Abnormal NPC = >7cm

N = 48 concussed athletes; Mean = 61 days post-injury
Total Symptom Scores for Normal and Abnormal Convergence Groups

- Normal Convergence
  - Symptom Score: 11.4
- Abnormal Convergence
  - Symptom Score: 17

Significance: $p = .05^*$

N = 48 concussed athletes; Mean = 61 days post-injury
Summary

• First study to examine near point of convergence and computerized neurocognitive test results in a sample of athletes with post-concussion syndrome.

• Athletes with Convergence Insufficiency following concussion scored lower on Verbal Memory, were slower in Reaction Time and reported higher symptom scores.

• Provides targeted assessment for treatment/rehab pathway; Data in preparation showing efficacy of behavioral vision therapy (HTS program) in treating cohort of concussed patients with convergence insufficiency.
Case Example

Major League Baseball-Catcher 2012
Case Example: MLB Catcher-History of four prior concussions and event on March 11, 2012

April 4, 2012
- Detailed Clinical Interview
  - All symptoms persistent and moderate/severe

Vestibular-Ocular Examination
- NPC (Near Point of Convergence = 27cm)
- Difficulties with gaze stability
- Optokinetic Sensitivity

Exertional Testing
- Only able to tolerate stationary bike for 15 minutes
  - Unable to tolerate more dynamic activity
- No other exertional testing due to severity of provocation

Computerized Neurocognitive Testing
Show Neurocognitive Data
Case Example: MLB Catcher

- Impressions-Chronic post-concussion syndrome from recent and prior mTBI’s
  - 2011 symptoms likely post concussive in nature
  - Difficulties chronic
  - Symptom concerns-Vestibular, Ocular, Cognitive, Mood, Sleep

- April 4, 2012 Treatment Recommendations
  - Targeted Vestibular therapy (optokinetic sensitivity, gaze instability)
  - Vision therapy (HTS program) for convergence insufficiency
  - Exertional therapy (stationary bike, core work, strengthening-quiet gym)
  - PMR-prescribed Amantadine, Ambien, Klonopin,
  - Monthly follow-up appointments at UPMC
Using Concussion Clinical Trajectories to Inform Targeted Treatment Pathways

Risk Factors: Previous Concussions, Migraine, LD/ADHD, Sex, Age, Motion sensitiivty, Ocular Hx?

Concussion → Concussion Clinical Trajectories → Treatment and Rehab Pathways

Clinical Trajectories:
- Vestibular
- Ocular
- Cognitive
- Migraine
- Anxiety/Mood
- Cervical
Case Example: MLB Catcher

August 7, 2012

Clinical interview
- Had progressed significantly with Vision, Vestibular and Exertional therapies
- Reported being 95%-no physical symptoms reported-sleep/mood WNL
- Had discontinued Ambien/Klonopin (continued on Amantadine)
- NPC=3cm; All Vestibular-Ocular testing WNL
- Neurocognitive Testing significantly improved
- Recommended progression to baseball activities, continue with exertional training (discontinue vestibular, vision therapies)
- Wean off meds
- Return for clearance

September 6, 2012-Final Evaluation
- 100% asymptomatic, off all medications, Neurocognitive data WNL
- **Full clearance to Winter League Baseball**
Thank You