PSYCHIATRIC DISORDERS

POWERPOINT PRESENTATION
NEUROPSYCHIATRIC EFFECTS OF CONCUSSION
No Relevant Conflicts of Interest to Report

- Supported by
  - NIH
    - R01NS055020 (NINDS)
    - R01HD048638 (Biomedical Research Partnership – NICHD: Simbex; Dartmouth Medical School; Brown University; Virginia Tech)
  - CDC
    - R01 CE001254
  - National Operating Committee on Standards for Athletic Equipment (NOCSAE 04-07)
  - GE/NFL Head Health Medical Advisory Board
Overview

• What do we know about psychiatric disorders in mild TBI in general and sports concussion in particular

• What is the relationship between profile of injury and behavioral/psychiatric disorders

• Complex interactions between injury characteristics and the head that is injured

• What do we know about effects of repetitive impacts
Major Categories of Neurobehavioral Sequelae

- Almost half of individuals who sustain a TBI will develop a neuropsychiatric disorder
  - Dysexecutive Syndromes ("personality changes")
    - Disorders of Social comportment
    - Disorders of Motivation
  - Cognitive Deficits
    - Memory, attention, executive cog functions
  - Psychiatric Disorders
    - Depression, anxiety, PTSD
Mechanisms of Concussion and MTBI

*Ropper and Gorson*

**Impact Forces:** (contact with object)

**Inertial Forces:** (acceleration or deceleration of the brain)

---

**Figure 1. Mechanism of Concussion.**
Biomechanical investigations dating back to the beginning of the 20th century suggest that concussion results from a rotational motion of the cerebral hemispheres in the anterior-posterior plane, around the fulcrum of the fixed-in-place upper brain stem. If the neck is restrained, concussion is difficult to produce. Concussions as portrayed in movies and cartoons, in which the back of the head is struck with a blunt object and no motion is transferred to the brain, are implausible. The modern view is that there is disruption of the electrophysiological and subcellular activities of the neurons of the reticular activating system that are situated in the midbrain and diencephalic region, where the maximal rotational forces are exerted. Alternative mechanisms for concussive loss of consciousnessness, such as self-limited cortical seizures or a sudden increase in intracranial pressure, have also been proposed, but with limited supporting evidence.
Regional Anatomical Vulnerability

Figure 3. (A) Brain regions vulnerable to damage in a typical traumatic brain injury (TBI, from ref 112); (B) Relationship of vulnerable brain regions to common neurobehavioral sequelae associated with TBI.

Vulnerability of Key Neurobehavioral Neurotransmitter Systems

Dopamine Pathways (meso-limbic; meso-cortical)

(From http://www.onu.edu/user/FS/tfaulkner/Dopamine.htm)


Serotonin System - Adapted from BG Lehmkuhle 2000
Figure 2. Outline of frontal subcortical circuits relevant to common neurobehavioral sequelae of traumatic brain injury (TBI).
Copyright © Cambridge University Press, 2001
Empirical Data in Concussion and Repetitive Impacts

- Largely lacking

- Information we have based on:
  - TBI
  - Mild TBI of multiple etiologies
  - Anecdotal reports
## Mild TBI and Psychiatric Disorders

### TABLE 15-7. Mild traumatic brain injury and subsequent psychopathology

<table>
<thead>
<tr>
<th>Syndrome</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Emotional distress&quot;</td>
<td>General symptom inventories generally elevated in minor TBI. Mixed symptom picture.</td>
</tr>
<tr>
<td>Mania</td>
<td>May occur after very mild TBI, even without loss of consciousness (Bracken 1987; Nizamio et al. 1983; Popo et al. 1988; Rios et al. 1987; Zwil et al. 1990). Increased relative risk of bipolar disorder (van Reekum et al. 2000). May have increased frequency of &quot;irritable mania.&quot;</td>
</tr>
<tr>
<td>Psychotic disorders</td>
<td>Relatively rare complication. Can be associated with TBI-induced affective disorders. In genetically vulnerable individuals, even mild TBI associated with increased risk of psychotic disorders (Malaspina et al. 2001).</td>
</tr>
<tr>
<td>Anxiety disorders</td>
<td>Symptoms consistent with anxiety often endorsed, but may not be more frequent than in general population (Schoenhuber and Gentili 1988). Generalized anxiety disorder found in roughly 25% (Fann et al. 1995). Increased rate of generalized anxiety disorder (van Reekum et al. 2000).</td>
</tr>
<tr>
<td>Posttraumatic stress disorder</td>
<td>Posttraumatic stress disorder seen in up to 20%–30% (Bryant and Harvey 1995a, 1999b; Mayou et al. 2000), higher in some military combat populations (Hoge et al. 2008; Schneiderman et al. 2008).</td>
</tr>
</tbody>
</table>

Note: TBI = traumatic brain injury.
Depressive Syndromes in TBI

• The most common psychiatric sequelae
  – 25-30% prevalence
  – Different determinants acute vs. chronic
    • Profile of injury in acute, meaning of injury in chronic
  – Need to distinguish depressive symptoms from depressive disorder

• Impacts on symptom burden, outcome measures, and recovery trajectory
What About Sports Concussion?

• Little epidemiological data (mainly depression)
• Some case series and anecdotal data
  – CTE
    • Prominent behavioral symptoms reported
    • Symptoms are non-specific
      – Personality change
      – Substance abuse
      – Depression
      – Similar to behavioral manifestations of FTD syndromes
Depressive Symptoms After a Single Concussion

Depression and Neurocognitive Performance After Concussion Among Male and Female High School and Collegiate Athletes

Anthony P. Kontos, PhD, Tracey Covassin, PhD, R.J. Elbin, PhD, Tonya Parker, PhD


Key Words: Brain injuries; Concussion, mild; Depression; Rehabilitation; Symptoms
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Table 3: Correlations Between Depression Scores and Neurocognitive Performance and Symptoms After Concussion (N=75)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Depression at 2d</th>
<th>Depression at 7d</th>
<th>Depression at 14d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>$r^2$</td>
<td>Cognitive</td>
</tr>
<tr>
<td>Verbal memory</td>
<td>-.17</td>
<td>.03</td>
<td>.05</td>
</tr>
<tr>
<td>Visual memory</td>
<td>-.21</td>
<td>.04</td>
<td>-.04</td>
</tr>
<tr>
<td>Processing speed</td>
<td>-.15</td>
<td>.02</td>
<td>.05</td>
</tr>
<tr>
<td>Reaction time</td>
<td>.25</td>
<td>.06</td>
<td>-.04</td>
</tr>
<tr>
<td>Symptoms</td>
<td>.20</td>
<td>.04</td>
<td>.08</td>
</tr>
</tbody>
</table>

Fig 1. Depression scores on the BDI-II after sport-related concussion (N=75). *$P<.05$. †Significantly higher than baseline.

Arch Phys Med Rehabil Vol 93, October 2012
Overlap of Post Concussive & Psychiatric Symptoms

The Rivermead Post Concussion Symptoms Questionnaire

After a head injury or accident some people experience symptoms which can cause worry or nuisance. We would like to know if you now suffer from any of the symptoms given below. As many of these symptoms occur normally, we would like you to compare yourself now with before the accident. For each one, please circle the number closest to your answer.

0 = Not experienced at all
1 = No more of a problem
2 = A mild problem
3 = A moderate problem
4 = A severe problem

Compared with before the accident, do you now (i.e., over the last 24 hours) suffer from:

- Headache
- Feelings of dizziness
- Nausea and/or vomiting
- Noise sensitivity, easily upset by loud noise
- Sleep disturbance
- Fatigue, tiring more easily
- Being irritable, easily angered
- Feeling depressed or tearful
- Feeling frustrated or impatient
- Forgetfulness, poor memory
- Poor concentration
- Taking longer to think
- Blurred vision
- Light sensitivity, easily upset by bright light
- Double vision
- Restlessness

Are you experiencing any other difficulties?

1. 
2. 

FIGURE 15-1. Rivermead Post Concussion Symptoms Questionnaire.

Overlap of Post Concussive and Psychiatric Symptoms
SCAT3: Symptom Overlap…..

**SYMPTOM EVALUATION**

<table>
<thead>
<tr>
<th>How do you feel?</th>
<th>score</th>
<th>score</th>
<th>score</th>
<th>score</th>
<th>score</th>
<th>score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure in head</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dizziness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blurred vision</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Tinnitus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ringing in ears</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Feeling slowed down</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Feeling like in a fog</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don’t feel right</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigue or low energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drowsiness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More emotional</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Irritability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sadness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home or disoriented</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of symptoms (maximum possible 22)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptom severity score (maximum possible 33)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Immediate memory score total**

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Digits Backward</th>
<th>Digits Rooster</th>
</tr>
</thead>
<tbody>
<tr>
<td>List</td>
<td>Top 1</td>
<td>Top 1</td>
</tr>
<tr>
<td>6, 5, 3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>5, 8, 1, 4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6, 2, 7, 8</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>7, 1, 8, 2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

**Concentration:**

Month in Reverse Order

Dec, Nov, Oct, Sept, Aug, Jul, Jun, May, Apr, Mar

**Concentration score**

**Neck Examination:**

- Range of motion
- Tenderness
- Upper

**Findings:**

**Balance examination**

Do one or both of the following tests:

- Posturography (sensorineural, balance, nore, etc.)
- Modified Balance Error Scoring System II

**Condition**

- Double-leg stance
- Simple leg stance (one-dominant foot)
- Tandem stance (non-dominant foot first)

**And/or**

- Tandem gait

**Time (best of 3 tries):** seconds

**Coordination examination**

- Upper limb coordination
- Which arm was used

**Coordination score**

**SAC Delayed Recall**

- Delayed recall score
**Hamilton Anxiety Inventory**

**Hamilton Anxiety Rating Scale (HAM-A)**

Below is a list of phrases that describe certain feelings that people have. Rate the patient by finding the answer which best describes the extent to which he/she has these conditions. Select one of the five responses for each of the fourteen questions.

<table>
<thead>
<tr>
<th>Hamilton Anxiety Rating Scale (HAM-A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = Not present, 1 = Mild, 2 = Moderate, 3 = Severe, 4 = Very severe.</td>
</tr>
<tr>
<td><strong>1.</strong> Anxious mood 0 1 2 3 4</td>
</tr>
<tr>
<td>Worries, anticipation of the worst, fearful anticipation, irritability.</td>
</tr>
<tr>
<td><strong>2.</strong> Tension 0 1 2 3 4</td>
</tr>
<tr>
<td>Feelings of tension, fatigability, startle response, moved to tears easily, trembling, feelings of restlessness, inability to relax.</td>
</tr>
<tr>
<td><strong>3.</strong> Fears 0 1 2 3 4</td>
</tr>
<tr>
<td>Of dark, of strangers, of being left alone, of animals, of traffic, of crowds.</td>
</tr>
<tr>
<td><strong>4.</strong> Insomnia 0 1 2 3 4</td>
</tr>
<tr>
<td>Difficulty in falling asleep, broken sleep, unsatisfying sleep and fatigue on waking, dreams, nightmares, night terrors.</td>
</tr>
<tr>
<td><strong>5.</strong> Intellectual 0 1 2 3 4</td>
</tr>
<tr>
<td>Difficulty in concentration, poor memory.</td>
</tr>
<tr>
<td><strong>6.</strong> Depressed mood 0 1 2 3 4</td>
</tr>
<tr>
<td>Loss of interest, lack of pleasure in hobbies, depression, early waking, diurnal swing.</td>
</tr>
<tr>
<td><strong>7.</strong> Somatic (muscular) 0 1 2 3 4</td>
</tr>
<tr>
<td>Pains and aches, twitching, stiffnes, myoclonic jerks, gringing of teeth, unsteady voice, increased muscular tone.</td>
</tr>
<tr>
<td><strong>8.</strong> Somatic (sensory) 0 1 2 3 4</td>
</tr>
<tr>
<td>Tinnitus, blurring of vision, hot and cold flushes, feelings of weakness, prickling sensation.</td>
</tr>
<tr>
<td><strong>9.</strong> Cardiovascular symptoms 0 1 2 3 4</td>
</tr>
<tr>
<td>Tachycardia, palpitations, pain in chest, throbbing of vessels, fainting feelings, missing beat.</td>
</tr>
<tr>
<td><strong>10.</strong> Respiratory symptoms 0 1 2 3 4</td>
</tr>
<tr>
<td>Pressure or constriction in chest, choking feelings, sighing, dyspnea.</td>
</tr>
<tr>
<td><strong>11.</strong> Gastrointestinal symptoms 0 1 2 3 4</td>
</tr>
<tr>
<td>Difficulty in swallowing, wind abdominal pain, burning sensations, abdominal fullness, nausea, vomiting, borborygmi, looseness of bowels, loss of weight, constipation.</td>
</tr>
<tr>
<td><strong>12.</strong> Genitourinary symptoms 0 1 2 3 4</td>
</tr>
<tr>
<td>Frequency of micturition, urgency of micturition, amenorrhoea, menorrhagia, development of frigidity, premature ejaculation, loss of libido, impotence.</td>
</tr>
<tr>
<td><strong>13.</strong> Autonomic symptoms 0 1 2 3 4</td>
</tr>
<tr>
<td>Dry mouth, flushing, pallor, tendency to sweat, giddiness, tension headache, raising of hair.</td>
</tr>
<tr>
<td><strong>14.</strong> Behavior at interview 0 1 2 3 4</td>
</tr>
<tr>
<td>Fidgeting, restlessness or pacing, trimmer of hands, furrowed brow, strained face, sighing or rapid respiration, facial pallor, swallowing, etc.</td>
</tr>
</tbody>
</table>
## Beck Depression Inventory

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
</table>
| 11.  | Agitation | 0 | Slight
|      | 1 | Moderate
|      | 2 | Severe
|      | 3 | Extreme
| 12.  | Loss of Interest | 0 | None
|      | 1 | Mild
|      | 2 | Moderate
|      | 3 | Severe
| 13.  | Indifference | 0 | None
|      | 1 | Mild
|      | 2 | Moderate
|      | 3 | Severe
| 14.  | Worthlessness | 0 | None
|      | 1 | Mild
|      | 2 | Moderate
|      | 3 | Severe
| 15.  | Loss of Energy | 0 | None
|      | 1 | Mild
|      | 2 | Moderate
|      | 3 | Severe
| 16.  | Change in Sleep | 0 | None
|      | 1 | Mild
|      | 2 | Moderate
|      | 3 | Severe
| 17.  | Irritability | 0 | None
|      | 1 | Mild
|      | 2 | Moderate
|      | 3 | Severe
| 18.  | Changes in Appetite | 0 | None
|      | 1 | Mild
|      | 2 | Moderate
|      | 3 | Severe
| 19.  | Concentration Difficulty | 0 | None
|      | 1 | Mild
|      | 2 | Moderate
|      | 3 | Severe
| 20.  | Tiredness or Fatigue | 0 | None
|      | 1 | Mild
|      | 2 | Moderate
|      | 3 | Severe
| 21.  | Loss of Interest in Sex | 0 | None
|      | 1 | Mild
|      | 2 | Moderate
|      | 3 | Severe

### Instructions
- Rate each item according to the severity of the symptom.
- Score each item from 0 to 3, where 0 is none and 3 is extreme.

### Example
- Agitation: I am not restless or wound up than usual.
- Loss of Interest: I have no interest in other people or activities.
- Indifference: I am less interested in other people or things.
- Worthlessness: I feel worthless.
- Loss of Energy: I have less energy than usual.
- Change in Sleep: I have experienced any change in my sleeping pattern.
- Irritability: I am no more irritable than usual.
- Changes in Appetite: My appetite has changed.
- Concentration Difficulty: I can concentrate as usual.
- Tiredness or Fatigue: I feel tired.
- Loss of Interest in Sex: I have no interest in sex.
Nine-Year Risk of Depression Diagnosis Increases With Increasing Self-Reported Concussions in Retired Professional Football Players

Zachary Y. Kerr, MPH, MA, Stephen W. Marshall, PhD, Hendren J. Fehlings, MD, and Kevin M. Guskiewicz, PhD, ATC.

Investigation performed at the University of North Carolina at Chapel Hill.

Background: Concussions may exacerbate the progression to long-term mental health outcomes such as depression in athletes. Previous studies have demonstrated the effects of recurrent concussions on the clinical diagnosis of depression in a group of retired football players.

Study Design: Cohort study, Level of evidence: 2.

Methods: Members of the National Football League Retired Players Association responded to a baseline General Health Survey (GHS) in 2001. They also completed a follow-up survey in 2010. Both surveys asked about demographic information, history of concussions sustained during their professional football career, physical/mental health, and presence of diagnosed medical conditions. A physical component summary (Short Form 36 Measurement Model for Functional Assessment of Health and Well-Being [SF-36 PCS]) was calculated from responses to the physical health-related quality-of-life subscale. The GHS collected data on depression via the Center for Epidemiologic Studies Depression Scale (CES-D) and the Revised Beck Depression Inventory (BDI-R). The CES-D was administered at the baseline survey, and the BDI-R was administered at the follow-up survey.

Results: Of the 2,603 respondents, 1,119 respondents had complete data. The prevalence of depression was 2.4% (51) at baseline and 4.2% (89) at follow-up. The increase in the rate of depression was statistically significant (P < 0.01) across all categories of concussions sustained during professional football careers.

Conclusion: The increase in the rate of depression was statistically significant (P < 0.01) across all categories of concussions sustained during professional football careers.

Vol. 40, No. 10, 2012

TABLE 1

Crude and Adjusted Risk Ratios and 95% Confidence Intervals for the Association Between Self-Reported Concussion History and 2001-2010 Depression Diagnosis in a Cohort of Former Professional Football Players

<table>
<thead>
<tr>
<th>No. of Concussions Sustained During Professional Career</th>
<th>Players With 2001-2010 Clinical Diagnosis of Depression, n (%)</th>
<th>Total</th>
<th>Crude RR (95% CI)</th>
<th>Adjusted RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>11 (3.0)</td>
<td>365</td>
<td>1 (reference)</td>
<td>1 (reference)</td>
</tr>
<tr>
<td>1-2</td>
<td>22 (8.2)</td>
<td>269</td>
<td>2.7 (1.3-5.5)</td>
<td>2.3 (1.1-4.7)</td>
</tr>
<tr>
<td>3-4</td>
<td>26 (18.7)</td>
<td>204</td>
<td>4.9 (2.9-9.0)</td>
<td>3.3 (1.7-6.7)</td>
</tr>
<tr>
<td>5-8</td>
<td>26 (19.3)</td>
<td>135</td>
<td>6.4 (3.2-12.6)</td>
<td>4.1 (2.0-8.4)</td>
</tr>
<tr>
<td>10 or more</td>
<td>19 (26.8)</td>
<td>71</td>
<td>8.9 (4.4-17.6)</td>
<td>5.8 (2.5-12.2)</td>
</tr>
<tr>
<td>Total</td>
<td>106 (10.2)</td>
<td>1044</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Excludes all cohort members who had not reported having been diagnosed previously with clinical depression on the 2001 General Health Survey. RR, risk ratio; CI, confidence interval.

b Adjusted for years since retirement and the 2001 physical component summary on the Short Form 36 Measurement Model for Functional Assessment of Health and Well-Being.

6/27/2014
Depression After Multiple Concussions

Effects of Multiple Concussions on Retired National Hockey League Players

Jeffrey G. Caron,1 Gordon A. Bloom,1 Karen M. Johnston,2 and Catherine M. Sabiston1,2

1McGill University; 2University of Toronto

The purpose of this study was to understand the meanings and lived experiences of multiple concussions in professional hockey players using hermeneutic, idiographic, and inductive approaches within an interpretive phenomenological analysis. The interviewee was an athlete who had suffered multiple concussions, and the interviewees were five former National Hockey League athletes who had retired due to medically diagnosed concussions suffered during their careers. The men discussed the physical and psychological symptoms they experienced as a result of their concussions and how the symptoms affected their professional careers, personal relationships, and quality of life. The former professional athletes related these symptoms to the turmoil that is ever present in their lives. These findings are of interest to athletes, coaches, sport administrators, family members, sport psychology practitioners, and medical professionals, as they highlight the severity of short- and long-term effects of concussions.

Keywords: concussions, hockey, depression, social support

It was very tough for the first couple of years and especially through the depression. That was challenging but I think my family went through it worse than I did. I was full blown, let’s say, dementia. So I wasn’t really suffering anymore but everybody watching around me was suffering. . . . They were really worried.—Paul

The first time I went through a really deep depression. It was a very scary time. . . . If you hit your head hard enough, things can get really confusing. Things can come unraveled and you have no control. . . . People don’t understand going from, in their eyes, a hockey celebrity to the point where you can’t walk out of your house. You can’t shave. You have no desire to do anything. You’re depressed.—Zach

Went into a depression. There were two or three months where I was down and out. I didn’t feel good. I’d forget everything. Deep depression. Emotional, because you think your career is over. Really, I think my wife came home one day and I think I was under the table crying.—James
Regions of correlation between low FA and depressive symptoms in retired NFL cohort
Correlates of Depression in Retired NFL Players

Neuroimaging of Cognitive Dysfunction and Depression in Aging Retired National Football League Players

A Cross-sectional Study

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Objectives: To assess cognitive impairment and depression in aging former professional football (National Football League [NFL]) players and to identify neuroimaging correlates of these dysfunctions.

Design: We compared former NFL players with cognitive impairment and depression, cognitively normal retired players who were not depressed, and matched healthy control subjects.

Setting: Research center in the North Texas region of the United States.

Patients: Cross-sectional sample of former NFL players with and without a history of concussion recruited from the North Texas region and age-, education-, and IQ-matched controls. Thirty-four retired NFL players (mean age, 61.8 years) underwent neurological and neuropsychological assessment. A subset of 26 players also underwent detailed neuroimaging; imaging data in this subset were compared with imaging data acquired in 26 healthy matched controls.

Main Outcome Measures: Neuropsychological measures, clinical diagnoses of depression, neuroimaging measures of white matter pathology, and a measure of cerebral blood flow.

Results: Of the 34 former NFL players, 20 were cognitively normal. Four were diagnosed as having a fixed cognitive deficit; 8, mild cognitive impairment; 1, dementia; and 8, depression. Of the subgroup in whom neuroimaging data were acquired, cognitively impaired participants showed the greatest deficits on tests of naming, word finding, and visual/verbal episodic memory. We found significant differences in white matter abnormalities in cognitively impaired and depressed retired players compared with their respective controls. Regional blood flow differences in the cognitively impaired group (left temporal pole, inferior parietal lobule, and superior temporal gyrus) corresponded to regions associated with impaired neurocognitive performance (problems with memory, naming, and word finding).

Conclusions: Cognitive deficits and depression appear to be more common in aging former NFL players compared with healthy controls. These deficits are correlated with white matter abnormalities and changes in regional cerebral blood flow.

Depression After Mild TBI

- 21 year old collegiate soccer player
  - 3rd concussion
  - Poor recovery trajectory after 10 months
    - Fatigue, headache, recurrent symptoms with exertion, disturbed sleep, academic and cognitive difficulties
  - Multiple sports medicine specialists and neurodiagnostic procedures
Depression After Mild TBI

• Exam
  – Very focused on concussion concerns
  – Effect of injury on his life
    • Social network
    • Identity
    • Family
  – Additional symptoms

• Treatment
The Head That Is Injured

Not just the profile of injury but the person who is injured:
- Pre-existing psychiatric injury
- Genetic pre-disposition
  - Candidate alleles may play a role
- The meaning of the injury
  - Injury as threat to identity
  - “exit strategy” for reluctant athletes
  - Complex dynamics with parents/family
Focus Has Been on Concussion

• What about:
  – Those not identified as concussed?
    • Not recognized
    • Not reported
  – Effects of repetitive subconcussive impacts?
  – Is there cause for concern?
“Career” (High School & College) Exposure

- ~3000 hits over 4 years of high school
- ~5000 hits over 4 years of college
- ~8000 total over 8 year “career”
  - Adapted from Broglio et al. (2011) J of Neurotrauma
Effect of Repetitive Head Impacts

- Effects on
  - Cognition (McAllister et al. *Neurology*, 2012)
  - Brain structure (McAllister et al. *Neurology* 2013)
  - Brain function (fMRI)
  - Mood, anxiety, behavior?
Effect of Repetitive Impacts on Mood and Anxiety

- Measures of mood (BDI) and anxiety (state/trait)
  - Pre and post season
    - Collegiate Non-contact athletes (n=74)
    - Collegiate hockey players non-concussed (n=24)
    - Concussed collegiate hockey players (n=8)

- No clinically significant differences at pre or post season

- There was a main effect of group on BDI
Summary

• TBI associated with increased relative risk of neurobehavioral disorders
• Related to profile of regional brain injury associated with “typical” TBI
• Evidence in sports-related TBI emerging:
  – Depression has received most attention
  – Highly selective cohort of reported CTE cases have prominent neurobehavioral signs and symptoms
  – Reason for theoretical concern