Traumatic Brain Injury & Visual Impairment

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No Financial Disclosures
TBI in Military Personnel

DoD TBI data for US forces worldwide 2000-2013

Mild TBI 82.4%
Moderate TBI 8.2%
Severe TBI 1.0%
Penetrating TBI 1.6%
Not classifiable 6.8%

DVBIC data May 2013Q1
Percentage of TBI Patients with Visual Symptoms

- **Military**
  - PRC /PNS: 74-76%<sup>2,5</sup>
  - Polytrauma/TBI: 76%<sup>6</sup>
  - TBI: 75%<sup>6</sup>
  - PRC blast: 66%<sup>7</sup>
  - PRC non-blast: 69%<sup>7</sup>

- **Civilian Estimates**: 45-60%<sup>8,9</sup>
# Types of Visual Symptoms in TBI

<table>
<thead>
<tr>
<th>Symptom</th>
<th>In-patient</th>
<th>Out-patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photophobia&lt;sup&gt;6,8,10&lt;/sup&gt;</td>
<td>7%</td>
<td>13-59%</td>
</tr>
<tr>
<td>Diplopia&lt;sup&gt;2,6&lt;/sup&gt;</td>
<td>7%</td>
<td>8-15%</td>
</tr>
<tr>
<td>Eyestrain&lt;sup&gt;10&lt;/sup&gt;</td>
<td></td>
<td>35%</td>
</tr>
<tr>
<td>Blur when reading&lt;sup&gt;10&lt;/sup&gt;</td>
<td></td>
<td>35%</td>
</tr>
<tr>
<td>Loss of place reading&lt;sup&gt;10&lt;/sup&gt;</td>
<td></td>
<td>60%</td>
</tr>
<tr>
<td>Reduced reading speed&lt;sup&gt;10&lt;/sup&gt;</td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td>Words run together&lt;sup&gt;10&lt;/sup&gt;</td>
<td></td>
<td>40%</td>
</tr>
<tr>
<td>Reduced reading comprehension&lt;sup&gt;10&lt;/sup&gt;</td>
<td></td>
<td>40%</td>
</tr>
</tbody>
</table>
Figure 1.
Percentage of patients with subjective vision complaints and reading performance deficits. The number of patients with each anomaly/total number of patients measured is given in each bar. *Light sensitivity was found at a significantly higher frequency in the BR TBI group (p = 0.002).

Goodrich, et. al., 2013
# Visual Acuity and TBI

<table>
<thead>
<tr>
<th>Acuity level</th>
<th>Civilian(^8)</th>
<th>PRC(^5)</th>
<th>PNS(^5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/60 or better</td>
<td>85%</td>
<td>78%</td>
<td>98%</td>
</tr>
<tr>
<td>20/70 – 20/100</td>
<td>3%</td>
<td>6%</td>
<td>0%</td>
</tr>
<tr>
<td>Worse than 20/100</td>
<td>5%</td>
<td>13%</td>
<td>2%</td>
</tr>
<tr>
<td>NLP (1 or both eyes)</td>
<td>7%</td>
<td>3% (OU)</td>
<td>0%</td>
</tr>
</tbody>
</table>
## Visual Field Defects and TBI

<table>
<thead>
<tr>
<th>Type of VF Defect</th>
<th>Civilian</th>
<th>PRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHH</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>LHH</td>
<td>4%</td>
<td>16%</td>
</tr>
<tr>
<td>Quadranopsia</td>
<td>6%</td>
<td>4%</td>
</tr>
</tbody>
</table>

http://www.lighthouse.org/about-low-vision-blindness/vision-disorders/hemianopia/
Accommodative Dysfunction and TBI

– Civilian
  • Alvarez, et al\textsuperscript{8}
  • Ciuffreda, et al\textsuperscript{11}

– Military
  • Goodrich, et al\textsuperscript{2}
  • Lew, et al\textsuperscript{12}
  • Stelmack, et al\textsuperscript{6}
  • Goodrich, et al\textsuperscript{7}
  | 24% | 41% |
  | 22% | 21% |
  | 47% | 64% NBR; 69% BR |
Convergence Insufficiency and TBI

- Civilian
  - Alvarez, et al\textsuperscript{8}
  - Ciuffreda, et al\textsuperscript{11}
  - Cohen, et al\textsuperscript{13}

- Military
  - Brahm, et al\textsuperscript{5}
  - Stelmack, et al\textsuperscript{6}
  - Goodrich, et al\textsuperscript{2}
  - Lew, et al\textsuperscript{12}
A Retrospective Study of the Prevalence of Visual Deficits after Mild TBI Secondary to Blast Exposure during Military Deployment

<table>
<thead>
<tr>
<th>BV/Accom Dx</th>
<th># of Subjects (26)</th>
<th>% of Subjects</th>
<th>% in General Adult Pop.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical</td>
<td>8</td>
<td>31</td>
<td>0.5 (HrT)</td>
</tr>
<tr>
<td>Ac Infacility</td>
<td>6</td>
<td>23</td>
<td>xx</td>
</tr>
<tr>
<td>CI</td>
<td>4</td>
<td>15</td>
<td>7.7</td>
</tr>
<tr>
<td>Ac Insufficiency</td>
<td>4</td>
<td>15</td>
<td>6.2</td>
</tr>
<tr>
<td>Strabismus</td>
<td>2</td>
<td>8</td>
<td>3.9</td>
</tr>
<tr>
<td>Basic EP</td>
<td>2</td>
<td>8</td>
<td>1.5</td>
</tr>
<tr>
<td>Ac Spasm</td>
<td>2</td>
<td>8</td>
<td>10.8</td>
</tr>
<tr>
<td>Basic XP</td>
<td>1</td>
<td>4</td>
<td>3.1</td>
</tr>
<tr>
<td>FVD</td>
<td>1</td>
<td>4</td>
<td>1.5</td>
</tr>
<tr>
<td>CN Palsy</td>
<td>1</td>
<td>4</td>
<td>xx</td>
</tr>
</tbody>
</table>
Military Patient Case:

• 27 year old male
• Active duty army sergeant
• CC:
  (+) Intermittent vertical diplopia
  (+) Words look “bunched up on the page” and he often skips lines when reading
  (+) Motion sickness and dizziness with walking
Additional History:

- 2 deployments
  - 2004-05 Iraq
  - 2/07-12/07 Iraq
- 6 IED blasts
- Last blast hit his vehicle and it was lifted from the ground
- He lost consciousness for 6 min

- Being treated for:
  - Headaches
  - PTSD
  - Dyslipidemia

- Being treated with:
  - Topamax (topiramate)
  - Klonopin (clonazepam)
  - Seroquel (quetiapine)
  - Lipitor (atorvastatin)
  - ASA

- POH (+) Glasses
Exam Findings:

- **Subjective Refraction:**
  - OD: -2.50 -2.00 x 014  20/20
  - OS: -2.50 -1.75 x 180  20/20
- **EOMs:** +1 OAIO OS
- **Maddox Rod @ near:**
<table>
<thead>
<tr>
<th>R</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>7BI, 3BU</td>
<td>5BI, 3BU</td>
</tr>
<tr>
<td>6BI, 2BU</td>
<td>6BI, 2BU</td>
</tr>
<tr>
<td>5BI, 3BU</td>
<td>5BI, 3BU</td>
</tr>
</tbody>
</table>

- **Associated Phoria:**
  - 2BU OD (Wesson)
- **Stereo acuity:**
  - Randot: 250”Global, 70” Local
  - With 2BU OD: 20” Local

Prism over OD
Outcome:

• Assessments:
  – CMA OU
  – Intermittent diplopia secondary to left hyper-deviation
  – Ruled out CN IV palsy

• Plan:
  – New spec Rx
  – 2BU OD Fresnel prism added to specs
  – F/U in 2 weeks
2 Week Follow-up Summary:

• Assessment:
  – OS hyper deviation with much improved symptoms since addition of prism

• Plan:
  – Prism will be ground into new spectacle Rx
Saccadic/Pursuit Dysfunction and TBI

- **Civilian**
  - Alvarez, et al\(^8\)
  - Ciuffreda, et al\(^{11}\)
- **Military**
  - Brahms, et al\(^5\)
  - Capo Aponte, et al\(^{10}\)
  - Goodrich, et al\(^2\)
  - Stelmack, et al\(^6\)
  - Goodrich, et al\(^7\)

\(^{8}\) 8%  
\(^{5}\) 30% PRC; 23% PNS  
\(^{10}\) 60% pursuit; 30% saccades  
\(^{2}\) 19%  
\(^{6}\) 6%  
\(^{7}\) Saccades NBR 84%; BR 48%  
\(^{7}\) Pursuits NBR 46%; BR 26%
## Oculomotor Deficits in TBI

<table>
<thead>
<tr>
<th></th>
<th>Military Estimates</th>
<th>Civilian Estimates</th>
<th>Non-TBI General Population Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accommodative Dysfunction</td>
<td>21-69%(^2,6,7,12)</td>
<td>24-41%(^8,11)</td>
<td>6-17%</td>
</tr>
<tr>
<td>Convergence Dysfunction</td>
<td>28-48%(^2,5,6,12)</td>
<td>23-56%(^8,11,13)</td>
<td>7-8%</td>
</tr>
<tr>
<td>Vertical Deviation</td>
<td>31-55%(^10,14)</td>
<td>Not Available</td>
<td>5-9% (20%)</td>
</tr>
<tr>
<td>Saccadic &amp;/or Pursuit Dysfunction</td>
<td>6-84%(^2,5,6,7,10)</td>
<td>8-51%(^8,11)</td>
<td>&lt;1.0%</td>
</tr>
</tbody>
</table>
Military Blast vs. Non-blast TBI

Figure 2.
Percentage of patients with oculomotor deficits. The number of patients with each anomaly/total number of patients measured is given in each bar.
*Saccadic was dysfunction was significantly higher in the NBR TBI group (p = 0.006).

Goodrich, et. al., 2013
Cranial Nerve III, IV, VI Palsies and TBI

• Civilian
  – Alvarez\(^8\) 6% 10% 4%
  – Ciuffreda\(^{11}\) 4% 3% 1%
  – VanStavern\(^{15}\) 12% 13% 6%

• Military
  – Goodrich\(^7\) (Data combines CN III, IV, VI palsies)
    • 16% of non-visually impaired
    • 42% of visually impaired
    • 20% of non-blast related polytrauma
    • 32% of blast related polytrauma
Ocular Pathology and TBI

• UK civilian study of 200 consecutive cases in an ED
• 84% of TBI patients had ocular findings within hours of admission to the ED\textsuperscript{16}
  – ON trauma
  – Corneal/scleral tears
  – Papilledema
  – Pupil abnormality
  – Orbital fracture
  – SCH
  – Peri-ocular ecchymosis
Overall, the military and civilian TBI populations have much in common
Patient Case: Soccer Player

- 28 year old male
- Professional soccer player
- CC: Concussion 2 months prior with visual & vestibular symptoms, difficulty tracking the ball, trouble with near asthenopia, and photophobia
- “Feeling off and out of balance” since concussion
- “How long until I can get back to practice and games?”
• Additional History:
  – Took header to right temple in practice
  – Felt “dizzy & out of it” afterward, continued with practice
  – C/O: intermittent blur, trouble focusing, trouble tracking, and photophobia x 2 months
  – Will be starting vestibular therapy soon
  – (+) Phonophobia
  – When he does light training, his symptoms increase
  – Prior concussion in 2003, but “fully healed from it”
  – No prior ocular or visual deficits in past
  – No prior systemic conditions
  – No medications
Exam Findings:

- DVAsc: 20/10 OD, OS
- NVAsc: 20/12.5 OD, OS
- Retinoscopy: plano OU
- Filter Eval: 550nm (I/O)
- CVF/AVF: normal OD, OS
- Pupils: normal OU
- OH: normal OD, OS
• EOM: FROM OU
• (+) end gaze nystagmus
• Pursuits adequate
• Saccades inaccurate
• NPC x 3: 7cm with effort
  Mild head shaking/tremor
• DCTsc: orthophoria
• NCTsc: 14pd XP
• Stereo: 250”G/25”L

• Prism Bar Vergence @ N:
  – BO: x/20/10
  – Significant effort
  – Scrunching forehead
• AA: 9D OD, OS
• MEMsc: +0.75D OD, OS
• Accom Facility +/- 2.00
  – 9 cycles/min with effort
  – Binoc. (+) more difficult
Initial Assessment & Plan

- Photophobia indoors/outdoors related to concussion
- Prescribe selective wavelength filter contact lenses (CL)
  - Counseled about induced color distortions
Military Patient
Filter Glasses

Oakley

Adidas

Oakley

Adidas
Initial Assessment & Plan

• Difficulty with saccadic accuracy after concussion
• Rx: HTS pursuit & saccadic therapy; 3 min each 2x/day
• At practice and games while on sidelines and in stands track ball in real time
Initial Assessment & Plan

- Asthenopia secondary to convergence insufficiency (CI)
- CI decompensated secondary to concussion
- Rx: Gross convergence therapy & HTS therapy: Vergence BO, Autoslide vergence, Jump ductions; 5 min each, 2x/day
Initial Assessment & Plan

• The eye movement deficits and CI may be contributing to the patient’s dizziness; however, likely otolith mislocation causing most of vestibular symptoms.
Initial Assessment & Plan

• All findings and recommendations conveyed to patient and his team trainer in person.
• Summary report sent to team physician.
• Summary sent to vestibular therapist.
### Follow-up Summary

<table>
<thead>
<tr>
<th>Time since initial eye examination</th>
<th>10 days</th>
<th>1 month</th>
<th>2 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance with Vision Rehab</td>
<td>Doing more than Rx’d</td>
<td>Reduced slightly</td>
<td>Stable</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Stable</td>
<td>Improving</td>
<td>Resolved</td>
</tr>
<tr>
<td>Kinesthetic Awareness</td>
<td>Improving</td>
<td>Normal</td>
<td>Normal</td>
</tr>
</tbody>
</table>
# Follow-up Summary

<table>
<thead>
<tr>
<th>Time since initial eye examination</th>
<th>10 days</th>
<th>1 month</th>
<th>2 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vergence</td>
<td>Improving</td>
<td>Significant Improvement</td>
<td>Better than goals</td>
</tr>
<tr>
<td>Saccades &amp; Pursuits</td>
<td>Stable</td>
<td>Pursuits good Sac improving</td>
<td>Normal</td>
</tr>
<tr>
<td>Vision Rehab</td>
<td>HTS+EcCircles</td>
<td>HTS+EcCircles</td>
<td>Discontinued</td>
</tr>
</tbody>
</table>
At time of vision rehab discharge:

• Loves his filter CLs!!!
• Vestibular therapy continues
• Started RTP protocol  
  – Light running, goal kicking
• Returned to game play 6.5 months after concussive event
2 years later:

– “My light sensitivity hasn’t been a problem for the past year now. I definitely found the tinted contacts helpful as a transitional step for me towards reintegrating into practice and play. I don’t have any real residual side effects from the concussion but find that I monitor potential symptoms more closely and still wear a rugby helmet for comfort and peace of mind...”
Final Thoughts
References


References


References


