Oculomotor Behavior of Acutely Concussed Patients undergoing Hyperbaric Oxygen Treatment
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Introduction

- Hyperbaric oxygen therapy (HBOT) – a promising new technique for treatment of TBI
  - Administration of oxygen at high pressure rates may reduce inflammation and speed up the brain’s recovery time and healing process.
  - New eye tracking technology, such as RightEye, offers an objective, reliable and quantifiable way of differentiating between individuals with different severities of TBI, and those without a TBI.

Methods

- 60 patients (47 males; 51 with a sports-related concussion), ages 8-19, treated with HBOT at Healing with Hyperbarics Clinic in Fargo, ND within 12 days after diagnosed concussion.
- Prior to treatment, the patients were assessed using the Acute Concussion Evaluation (ACE) checklist and the RightEye Brain Health EyeQ.
- HBOT performed in a Sechrist mono-place chamber, pressurized with 100% oxygen using a protocol for acute concussions that factors length of time from injury, number of previous concussions and extent of symptoms and others.
- Treatments were given as frequently as four hours apart and ideally on consecutive days until the patient achieved a sustained symptom free (SSF) status, defined as a patient being back to pre-concussed daily activities.
- After the HBOT treatment, the Brain Health EyeQ measurements were repeated and the data were analyzed.

Results

- Significant mean differences on RightEye Brain Health EyeQ metrics pre and post HBOT treatment.
- The mean pre-treatment ACE score was 9 (range of 2-18) with headaches being the primary symptom in 85% of the subjects.
- 51 (85%) patients achieved SSF after an average of 4.4 treatments (range 2-17). 9 patients discontinued treatments prior to achieving SSF for various reasons.
- RightEye Brain Health EyeQ metrics showed a significant improvement in most eye movement behaviors for acutely concussed patients undergoing HBOT.
- Improved oculomotor behavior correlated with improved symptoms in most cases.
- This technology may help to provide objective evidence of the efficacy of early concussion interventions, such as HBOT.

RightEye Brain Health EyeQ Sample Metrics

<table>
<thead>
<tr>
<th>Test</th>
<th>Metric</th>
<th>Pre-Test Mean</th>
<th>Post-Test Mean</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain Health EyeQ</td>
<td>Brain Health EyeQ Score</td>
<td>50</td>
<td>61*</td>
<td>0.284</td>
</tr>
<tr>
<td>Circular Smooth Pursuit</td>
<td>On Target Smooth Pursuit (%)</td>
<td>49</td>
<td>59*</td>
<td>0.230</td>
</tr>
<tr>
<td>Horizontal Smooth Pursuit</td>
<td>Smooth Pursuit Efficiency - Left Eye (mm)</td>
<td>23</td>
<td>18*</td>
<td></td>
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<tr>
<td>Vertical Smooth Pursuit</td>
<td>Eye Target Velocity Error - Left Eye (dps)</td>
<td>21</td>
<td>20*</td>
<td>0.019</td>
</tr>
<tr>
<td>Horizontal Saccades</td>
<td>Saccadic Velocity - Right Eye (dps)</td>
<td>59</td>
<td>51*</td>
<td>0.075</td>
</tr>
<tr>
<td>Vertical Saccades</td>
<td>Saccadic Amplitude - Left Eye (mm)</td>
<td>187</td>
<td>183*</td>
<td></td>
</tr>
<tr>
<td>Fixation Stability</td>
<td>Depth (+/- mm)</td>
<td>-24</td>
<td>-2*</td>
<td>0.001</td>
</tr>
<tr>
<td>Choice Reaction Time</td>
<td>Reaction Time (ms)</td>
<td>1075</td>
<td>936*</td>
<td>0.190</td>
</tr>
<tr>
<td>Discriminate Reaction Time</td>
<td>Processing Speed (ms)</td>
<td>478</td>
<td>379*</td>
<td></td>
</tr>
</tbody>
</table>

Conclusion

- RightEye Brain Health EyeQ metrics showed a significant improvement in most eye movement behaviors for acutely concussed patients undergoing HBOT.
- Improved oculomotor behavior correlated with improved symptoms in most cases.
- This technology may help to provide objective evidence of the efficacy of early concussion interventions, such as HBOT.

Future Directions

- Comparison of the rate of change in symptoms and oculomotor performance of concussed patients undergoing early HBOT intervention to a matched cohort control group that does not undergo HBOT treatment.
- Comparison of symptom and oculomotor outcomes of HBOT with a combined vision rehabilitation plus HBOT intervention for concussion.
- Addition of objective measure of vergences, electroretinography, open-field autorefration, optical coherence tomography, visual-evoked potential, and pupillometry.