Near Point of Convergence as a Clinical Predictor for Exercise Tolerance
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Background
- There is little research regarding the relationship between Near Point of Convergence (NPC) and Exercise Tolerance
- Exercise Tolerance can be tested in a clinical setting with a progressive exercise protocol
- 5 Step Active Rehab Protocol:
  - Step 1: Light Intensity, Heart Rate Zone 100-120 bpm, 10-12 minutes
  - Step 2: Moderate Intensity, Heart Rate Zone 120-140 bpm, 12-15 minutes
  - Step 3: Vigorous Intensity, Heart Rate Zone 140-160 bpm, 15-18 minutes
  - Step 4: Maximal Intensity, Heart Rate Zone 160-180 bpm, 20-25 minutes
  - Step 5: Maximal Intensity with Multi-Directional Movement, Heart Rate Zone 160-180 bpm, 30-45 minutes
- Once patient clears ARP Step 5 they are cleared to fully participate in non-contact and low risk sports with multi-directional movement
- NPC is a quick and easy biomarker for determining Convergence Insufficiency
- NPC values <9 cm are considered normal
- NPC values >9 cm are considered abnormal

Purpose
To use Near Point Convergence (NPC) measurements as a clinical predictor for exercise tolerance in patients with post-concussion syndrome (PCS).

Hypotheses
We hypothesized that:
- A normal NPC <9 cm implies high exercise tolerance
- An increasing abnormal NPC will correlate with exercise intolerance

Materials and Study Design
- Retrospective Cohort Chart Review
- A total of 60 patients over 200 clinical visits were included in the study.
- All patients were seen between 11/17/17 and 11/29/18
- Clinical visits occurred 200 days or fewer after injury
- All patients were between the ages of 12-25
- All patients went through an Exercise Tolerance Testing and a 5-step Active Rehab Protocol
- Near Point of Convergence was measured with a digital ultrasonic device that included an on board microprocessor accompanied with concussion specialist assessment upon each visit

Results

<table>
<thead>
<tr>
<th>ARP Step</th>
<th>NPC Average (cm)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16.97 ± 7.97</td>
<td>2.87 x 10^-14</td>
</tr>
<tr>
<td>2</td>
<td>16.70 ± 7.7</td>
<td>6.38 x 10^-14</td>
</tr>
<tr>
<td>3</td>
<td>14.1 ± 5.1</td>
<td>1.85 x 10^-13</td>
</tr>
<tr>
<td>4</td>
<td>10.95 ± 1.95</td>
<td>3.45 x 10^-14</td>
</tr>
<tr>
<td>5</td>
<td>8.61 ± 0.39</td>
<td>6.07 x 10^-2</td>
</tr>
</tbody>
</table>

Table 1: Represents the average measured NPC at each ARP Step. The P-Value compares the NPC average to the normal NPC Value, 9cm, at the 5% significance level.

Conclusions
- ARP step was observed to have a negative correlation with NPC
- Average NPC for ARP Steps 1, 2, 3, and 4 all were significantly greater than the normal NPC value of 9 cm, see Table 1.
- There is significantly higher percentage of patients in the ARP Step 5 level with < 9 cm NPC compared to ARP Step 1, 2, 3, and 4.
- The results suggest that an increasing abnormal NPC will translate to a lower ARP Step while a patient with a < 9 cm NPC can complete ARP Step 5 successfully.

Significance
The rapidly and easily performed NPC oculomotor test can be used as a clinical predictor for exercise tolerance and help guide what ARP step may be most appropriate for concussed patients.

References

Figure 1: Ultrasonic device with on board microprocessor (Left), and exercise equip used for ARP

Figure 2: Displays the average NPC at a given ARP Step as seen in Table 1

Figure 3: Displays the percentage of patients from the study with a < 9 cm NPC at a given ARP Step as seen in Table 2

Table 2: Displays the percent of clinic visits < 9 cm at each ARP Step. The P Value represents the significance of how different the proportions are when comparing ARP Steps 1, 2, 3, and 4 to ARP Step 5.