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[1]
- 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[2]
- NPC values <9 cm are considered normal
- NPC values >9 cm are considered abnormal

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

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

ARP Step	NPC Average (cm)	P Value
1	16.97 ± 7.97	2.87×10^{-19}
2	16.70 ± 7.7	6.38×10^{-16}
3	14.1 ± 5.1	1.85×10^{-10}
4	10.95 ± 1.95	3.45×10^{-6}
5	8.61 ± 0.39	0.0752

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

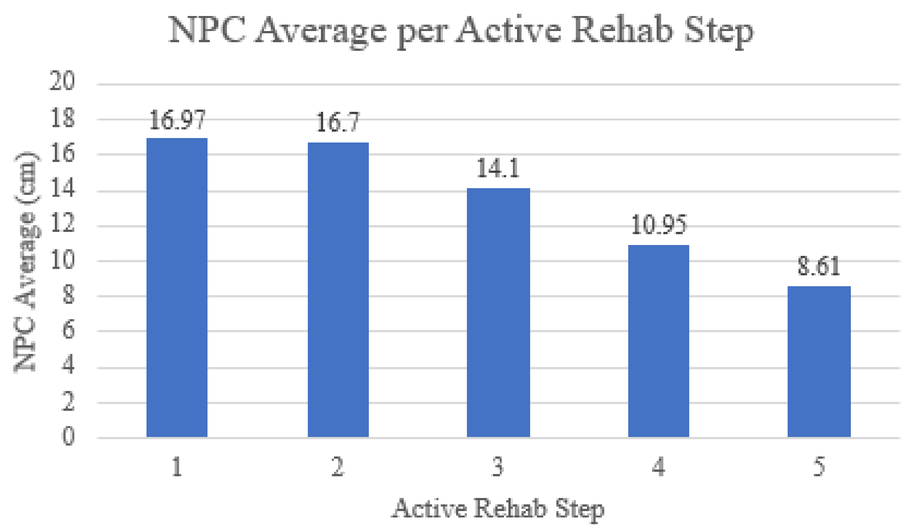

Figure 2: Displays the average NPC at a given ARP Step as seen in Table 1

ARP Step	Number of Clinical Visits	Percent of Visits < 9 cm	P Value
1	34	5.88	<.00001
2	30	10	<.00001
3	30	33.33	.0018
4	40	37.5	.0028
5	66	65.15	N/A

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

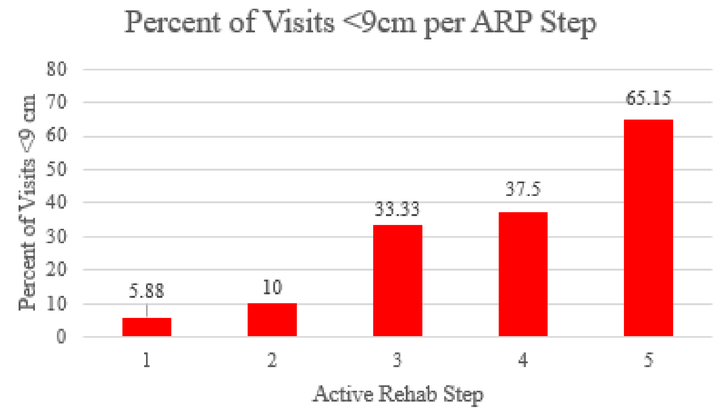

Figure 3: Displays the percentage of patients from the study with a < 9 cm NPC at a given ARP Step as seen in Table 2

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

1. Baker JG, et al. Return to Full Functioning after Graded Exercise Assessment and Progressive Exercise Treatment Post Concussion Syndrome. *Rehabilitation Research and Practice.* 2012;2012.
2. DuPrey KM, Webner D, Lyons A, Kucuk CH, Ellis JT, Cronholm PF. Convergence insufficiency identifies athletes at risk of prolonged recovery from sport-related concussion. *Am J Sports Med*. 2017;45(10):2388-2393.