Concussion-Related Vision Problems: Vision Rehabilitation

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Mitchell Scheiman, OD, PhD
Financial Disclosures

None
Presentation Overview

- Definitions
- Prevalence of vision problems after mTBI/concussion
- Screening
- Vision Rehabilitation – Demo
- Research
Three Component Model of Vision

- Visual Integrity
- Oculomotor Skills
- Visual Information Processing
Visual Integrity

Visual Acuity

Optics

Eye Health
Oculomotor Skills

- Saccades, Pursuits
- Binocular Vision
- Accommodation
Accommodation Disorders

Definition
- Age-related loss of accommodation
  - Structural
- Concussion-related loss of accommodation
  - Visual Pathway

Most common accommodative problem
- Accommodative Insufficiency
Binocular Vision Disorders

- **Convergence Insufficiency**
  - Condition in which eyes struggle to maintain convergence at near

- **Symptoms**
  - Eyestrain
  - Blurred vision
  - Double vision
  - Inability to sustain attention on task
  - Reduced comprehension
Eye Movement Disorders

- Eye movement problems
  - Saccades
  - Pursuits
Symptoms of Oculomotor Disorders

- Eyestrain
- Blurred vision
- Double vision
- Words moving on page
- Inability to sustain attention on task
- Reduced comprehension
- Loss of place
- Dizziness/nausea
Prevalence of Vision Deficits - Overview

**Normal Population**
- Binocular vision – 10%
- Accommodation – 3%
- Eye Movements – 2%

**After Concussion/mTBI**
- Binocular vision – 30%-45%
- Accommodation – 10%-50%
- Eye Movements – 20%-40%
# Prevalence Studies - Summary

<table>
<thead>
<tr>
<th>Problem</th>
<th>Goodrich N=46 Mean age=28</th>
<th>Brahm N=192 Mean age=28</th>
<th>Stelmack N=192 Mean age=31</th>
<th>Cuiffreda N=160 Mean age=42</th>
<th>Suchoff N=62 Mean age=49</th>
<th>Master/Scheiman N=100 Mean age=14</th>
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<tbody>
<tr>
<td>Convergence Insufficiency (10%)</td>
<td>30%</td>
<td>42%</td>
<td>28%</td>
<td>36%</td>
<td>42%</td>
<td>49%</td>
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<tr>
<td>Accommodative Dysfunction (3%)</td>
<td>22%</td>
<td>42%</td>
<td>47%</td>
<td>41%</td>
<td>10%</td>
<td>50%</td>
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<tr>
<td>Saccadic Dysfunction (2%)</td>
<td>20%</td>
<td>33%</td>
<td>9%</td>
<td>57%</td>
<td>40%</td>
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Impact on Recovery

- Retrospective cohort of 432 pediatric patients with concussion
- The main outcome of interest was time to clinical recovery
- Results: 378 of 432 subjects (88%) presented with vision or vestibular problems
- Conclusions: Vision and vestibular problems predict prolonged concussion recovery in children
- Vision assessments in concussion must near point of convergence, and accommodative amplitude
Primary Care Post-Concussion Vision Screening

**Most common problems:**
- Convergence insufficiency
- Accommodative Insufficiency

**Screening**
- Oculomotor Assessment Tool:
  - Near point of convergence
  - Accommodative amplitude
  - Saccades
  - Vergence facility

GuldenOphthalmics.com $79
Expected for children 6-<18 years old
NPC: <6 cm
NPA: <12 cm

Expected for adults 6-<18 years old
NPC: <6 cm
NPA: read result off rod
Treatment Options

- Lenses
- Prism
- Vision therapy/vision rehabilitation
Vision Therapy/Vision Rehabilitation

- Rehabilitation of ocular motor and other visual deficits using lenses, prisms, instrumentation, software
- Very basic techniques are sometimes integrated into physical therapy/vestibular Therapy
- Typically done by specialty trained optometrists
- In-office and home therapy components
Oculomotor Rehabilitation
VIDEO EXAMPLE
Aperture Rule
Is Oculomotor Rehabilitation Effective?
Vision Rehabilitation: Effectiveness

- More research in non-traumatic brain injury (TBI) patients
- Expanding research in TBI/concussion
A Randomized Clinical Trial of Treatments for Convergence Insufficiency in Children

Mitchell Scheiman, OD; G. Lynn Mitchell, MAS; Susan Cotter, OD; Jeffrey Cooper, OD, MS; Marjean Kulp, OD, MS; Michael Rouse, OD, MS; Eric Borsting, OD, MS; Richard London, MS, OD; Janice Wensveen, OD, PhD; for the Convergence Insufficiency Treatment Trial (CITT) Study Group

Objective: To compare vision therapy/orthoptics, pencil push-ups, and placebo vision therapy/orthoptics as treatments for symptomatic convergence insufficiency in children 9 to 18 years of age.

Methods: In a randomized, multicenter clinical trial, 47 children 9 to 18 years of age with symptomatic convergence insufficiency were randomly assigned to receive 12 weeks of office-based vision therapy/orthoptics, office-based placebo vision therapy/orthoptics, or home-based pencil push-ups therapy.

Main Outcome Measures: The primary outcome measure was the symptom score on the Convergence Insufficiency Symptom Survey. Secondary outcome measures were the near point of convergence and positive fusional vergence at near.

Results: Symptoms, which were similar in all groups at baseline, were significantly reduced in the vision therapy/orthoptics group (mean symptom score decreased from 32.1 to 9.5) but not in the pencil push-ups (mean symptom score decreased from 29.3 to 25.9) or placebo vision therapy/orthoptics groups (mean symptom score decreased from 30.7 to 24.2). Only patients in the vision therapy/orthoptics group demonstrated both statistically and clinically significant changes in the clinical measures of near point of convergence (from 13.7 cm to 4.5 cm; P < .001) and positive fusional vergence at near (from 12.5 prism diopters to 31.8 prism diopters; P < .001).

Conclusions: In this pilot study, vision therapy/orthoptics was more effective than pencil push-ups or placebo vision therapy/orthoptics in reducing symptoms and improving signs of convergence insufficiency in children 9 to 18 years of age. Neither pencil push-ups nor placebo vision therapy/orthoptics was effective in improving either symptoms or signs associated with convergence insufficiency.

Randomized Clinical Trial of Treatments for Symptomatic Convergence Insufficiency in Children

Convergence Insufficiency Treatment Trial Study Group*

Mitchell Scheiman, OD; Susan Cotter, OD, MS; G. Lynn Mitchell, MAS; Marjean Kulp, OD, MS; Michael Rouse, OD, MEd; Richard Hertle, MD; Maryann Redford, DDS, MPH; Jeffrey Cooper, MS, OD; Rachel Coulter, OD; Michael Gallaway, OD; David Granet, MD; Kristine Hopkins, OD, MSPH; Brian G. Mohney, MD; and Susanna Tamkins, OD.

**Objective:** To compare home-based pencil push-ups (HBPP), home-based computer vergence/accommodative therapy and pencil push-ups (HBCVAT+), office-based vergence/accommodative therapy with home reinforcement (OBVAT), and office-based placebo therapy with home reinforcement (OBPT) as treatments for symptomatic convergence insufficiency.

**Methods:** In a randomized clinical trial, 221 children aged 9 to 17 years with symptomatic convergence insufficiency were assigned to 1 of 4 treatments.

**Main Outcome Measures:** Convergence Insufficiency Symptom Survey score after 12 weeks of treatment. Secondary outcomes were near point of convergence and positive fusional vergence.

**Results:** After 12 weeks of treatment, the OBVAT group’s mean Convergence Insufficiency Symptom Survey score (15.1) was statistically significantly lower than those of 21.3, 24.7, and 21.9 in the HBCVAT+, HBPP, and OBPT groups, respectively ($P < .001$). The OBVAT group also demonstrated a significantly improved near point of convergence and positive fusional vergence at near compared with the other groups ($P \leq .005$ for all comparisons). A successful or improved outcome was found in 73%, 43%, 33%, and 35% of patients in the OBVAT, HBPP, HBCVAT+, and OBPT groups, respectively.

**Conclusions:** Twelve weeks of OBVAT results in a significantly greater improvement in symptoms and clinical measures of near point of convergence and positive fusional vergence and a greater percentage of patients reaching the predetermined criteria of success compared with HBPP, HBCVAT+, and OBPT.

**Application to Clinical Practice:** Office-based vergence accommodative therapy is an effective treatment for children with symptomatic convergence insufficiency.

**Trial Registration:** clinicaltrials.gov Identifier: NCT00338611

*Arch Ophthalmol.* 2008;126(10):1336-1349
Treatment of Accommodative Dysfunction in Children: Results from a Randomized Clinical Trial

Mitchell Scheiman*, Susan Cotter†, Marjean Taylor Kulp‡, G. Lynn Mitchell§, Jeffrey Cooper§,
Michael Gallaway¶, Kristine B. Hopkins¶, Mary Bartuccio**, Ida Chung**, and the Convergence Insufficiency Treatment Trial Study Group

ABSTRACT

Purpose. To report the effectiveness of various forms of vision therapy/orthoptics in improving accommodative amplitude and facility in children with symptomatic convergence insufficiency (CI) and co-existing accommodative dysfunction.

Methods. In a randomized clinical trial, 221 children aged 9 to 17 years with symptomatic CI were assigned to one of four treatments. Of the enrolled children, 164 (74%) had accommodative dysfunction; 63 (29%) had a decreased amplitude of accommodation with respect to age, 43 (19%) had decreased accommodative facility, and 58 (26%) had both. Analysis of variance models were used to compare mean accommodative amplitude and accommodative facility for each treatment group after 4, 8, and 12 weeks of treatment.

Results. After 12 weeks of treatment, the increases in amplitude of accommodation [office-based vergence/accommodative therapy with home reinforcement group (OBVAT) 9.9 D, home-based computer vergence/accommodative therapy group (HBCVAT+) 6.7 D, and home-based pencil push-up therapy group (HBPP) 5.8 D] were significantly greater than in the office-based placebo therapy (OBPT) group (2.2 D) (p-values <0.010). Significant increases in accommodative facility were found in all groups (OBVAT: 9 cpm, HBCVAT+: 7 cpm, HBPP: 5 cpm, OBPT: 5.5 cpm); only the improvement in the OBVAT group was significantly greater than that found in the OBPT group (p = 0.016). One year after completion of therapy, reoccurrence of decreased accommodative amplitude was present in only 12.5% and accommodative facility in only 11%.

Conclusions. Vision therapy/orthoptics is effective in improving accommodative amplitude and accommodative facility in school-aged children with symptomatic CI and accommodative dysfunction.

(Optom Vis Sci 2011;88:1–●●●●)
Mean CISS Scores by Group

No significant differences were observed between the HBPP, HBCVAT+, and OBPT groups (pair-wise p-values all ≥ 0.38).
Mean NPC break by Group

Mean adjusted NPC break

- HBPP
- HBCVAT+
- OBVAT
- OBPT

Study examination:
- Eligibility
- 4 week
- 8 week
- 12 week

Salus University
Non-surgical interventions for convergence insufficiency (Review)

Scheiman M, Gwiazda J, Li T

This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in The Cochrane Library 2011, Issue 3

https://www.thecochranelibrary.com
Recent Treatment Studies
Vision Rehab after mTBI


Research - Adults after mTBI

- Funded by Department of Defense
- Compared office-based VT to placebo VT in adult patients with mTBI
- Not only used placebo control, but first study to use objective measures of vergence
  - Not susceptible to bias
Results

- Objectives measures of vergence improved markedly
- Near-vision symptoms reduced along with improved visual attention
- None of the measures were found to change significantly following the placebo training
- Demonstrates brain visual system plasticity after mTBI in adult subjects
Objective Measures to Assess Effectiveness of VT
Objective Assessment of Vergence after Treatment of Concussion-Related CI: A Pilot Study

Mitchell M. Scheiman*, Henry Talasan†, Gladys Lynn Mitchell‡, and Tara L. Alvarez§

ABSTRACT

Purpose. To evaluate changes in objective measures of disparity vergence after office-based vision therapy (OBVT) for concussion-related convergence insufficiency (CI) and determine the feasibility of using this objective assessment as an outcome measure in a clinical trial.

Methods. This was a prospective, observational trial. All participants were treated with weekly OBVT with home reinforcement. Participants included two adolescents and three young adults with concussion-related, symptomatic CI. The primary outcome measure was average peak velocity for 4° symmetrical convergence steps. Other objective outcome measures of disparity vergence included time to peak velocity, latency, accuracy, settling time, and main sequence. We also evaluated saccadic eye movements using the same outcome measures. Changes in clinical measures (near point of convergence, positive fusional vergence at near, Convergence Insufficiency Symptom Survey [CISS] score) were evaluated.

Results. There were statistically significant and clinically meaningful changes in all clinical measures for convergence. Four of the five subjects met clinical success criteria. For the objective measures, we found a statistically significant increase in peak velocity, response accuracy to 4° symmetrical convergence and divergence step stimuli, and the main sequence ratio for convergence step stimuli. Objective saccadic eye movements (5 and 10°) appeared normal pre-OBVT and did not show any significant change after treatment.

Conclusions. This is the first report of the use of objective measures of disparity vergence as outcome measures for concussion-related convergence insufficiency. These measures provide additional information that is not accessible with clinical tests about underlying physiological mechanisms leading to changes in clinical findings and symptoms. The study results also demonstrate that patients with concussion can tolerate the visual demands (over 200 vergence and versional eye movements) during the 25-minute testing time and suggest that these measures could be used in a large-scale randomized clinical trial of concussion-related CI as outcome measures.

(Optom Vis Sci 2016;00:00–00)
Methods

Testing
- 5 subjects with symptomatic CI (2 children, 3 adults)
- Traditional clinical measures
- 144 disparity vergence stimuli presented

Treatment
- Office-based vision therapy
Methods – Outcome Exam

- Repeat baseline testing
  - Traditional clinical measures
  - Repeat objective eye movement testing
RESULTS
Non-symptomatic Binocularly Normal Control

- Multiple $4^\circ$ convergence movements
Variance of Positional Eye Movement Recordings Before and After Vision Therapy

Before OBVT

Subject: 5

Loss of Fusion

Subject: 3

Subject: 5

Subject: 3
Results/Conclusion

- Statistically significant changes in convergence:
  - Peak velocity: 14.8°/sec to 28°/sec (p=.004)
  - Accuracy: within 1° of stimulus to within 0.5° of stimulus (p=.011)

- VT is effective for concussion-related CI
Future Directions

Interventions for Convergence Insufficiency in Concussed Children (ICONICCC) Multi-center RCT

- 6 Children’s Hospitals/4 Colleges of Optometry, 1 Ophthalmology site
  - Philadelphia, PA
  - Boston, MA
  - Birmingham, AL
  - Stanford, CA
  - Ketchum University, CA
  - Cincinnati, OH

Specific Aim – To compare the effectiveness of 12 weeks of SCCC to SCCC + Home-based VT, SCCC+OBVT, for adolescents 11-17 years with persistent concussion symptoms PCS and symptomatic CI.
References

- CITT-ART Investigator Group. Treatment of Symptomatic Convergence Insufficiency in Children Enrolled in the Convergence Insufficiency Treatment Trial–Attention & Reading Trial: A Randomized Clinical Trial. Optom Vis Sci 2019;96:
Contact Information

Mitchell Scheiman
mscheiman@salus.edu

Thank You!