Effect of Optometric Visual Rehabilitation on a Cohort of Children with Reading based Learning Difficulties

Quaid, PT (MCOptom, FCOVD, PhD)[1,2], Cunningham, DJ (OD, FCOVD)[1]

VUE[3] Vision Therapy Network (Ontario, CANADA), [2]School of Optometry & Vision Science, University of Waterloo (Ontario, CANADA)

COVD 2019

VUE[3] Vision Therapy

COVD 2019

Introduction

- Over 82% of Individualized Educational Plans (IEPs) in Canada are primarily due to reading based learning difficulties (LD)[1].
- The average lost income to a LD individual is approximately $1.98 million (Canadian) with the average cost to the family being $455,000[1] between Grade 1 to Grade 12.
- Although efficient reading requires a number of mechanisms to function properly, oculomotor and visual processing anomalies are increasingly being recognized as significant contributing factors in literacy acquisition difficulties[2,3,4,5].
- Vision anomalies have been reported to be a primary reason for beginning reading failure in addition to being 3x more prevalent in ADHD individuals (convergence insufficiency for example shares 5 out of the 9 DSM criteria for ADHD)[6,7].
- Prevalence of binocular vision anomalies, including strabismus, amblyopia, convergence insufficiency and uncorrected refractive errors amount to conservatively 1 in 10 of the general population with potentially as high as 8 in 10 in LD environments[8].
- The total prevalence of binocular vision anomalies outweighs the prevalence of all ocular diseases combined in every age category (especially in paediatric cases)[8].
- This group has already published research which establishes a clear link between oculomotor efficiency, refractive error (in particular hyperopia) and reading ability[9].
- This prior research highlighted that using both near vergence facility and the CISS symptom questionnaire could predict grouping (i.e. IEP vs. Control) with an accuracy of >92% and that hyperopia >+1.25DS was a significant risk factor for poor reading ability[9].
- The current poster data is retrospective in nature, looking at 143 patients with IEP designation for reading based difficulties who completed their prescribed course of vision therapy within our clinic network. We tracked several oculomotor (OM) and visual information processing (VIP) metrics to establish essentially whether a "cause/effect" relationship is present and whether predictive metrics within the data exist.

Purpose

The main aim of this research was to establish the effect of rehabilitative vision therapy on the oculomotor, visual processing and reading metrics of children with dyseidetic reading issues (IEP status assigned) . A secondary aim was to determine whether any predictive visual metrics exists at baseline in terms of predicting poor reading ability as measured by the TOSWRF-2 reading efficiency battery (3-min decoding speed test).

Methods

- **Subjects**:
  - 143 paediatric cases aged 6-18 years old who completed our in-office VT program.
  - Retrospective chart review as all oculomotor data (OM) and visual information processing (VIP) data collected as part of clinic protocol every 10 sessions.
  - 56% male, 44% female (data collected from two main FCOVD doctors).
- **Protocol:**
  - Data collected by primary author (PQ) from all clinic files (3 FCOVDs in office).
  - TOSWRF-2 testing used in as it is a rapid 3-min test of reading efficiency.
  - TOSWRF-2 can be used easily within a school setting so this test chosen.
  - Retrospective cross-sectional file review approach.
- **Points of note**:
  - All cases were cyclopleged at baseline after doing dry retinoscopy (dynamic, Nott's).
  - VIP tests included in analysis: TVPS (3rd Edition), DEM, TOSWRF-2.
  - OM tests included in analysis: MAF (+/-2DS), BAF (+/-2DS), 12BO/3BI (near), stereopsis (randot), NPC testing.
  - Questionnaires included in analysis: CISS Questionnaire, COVD QoL Questionnaire.
  - Rehabilitative VT was only intervention being undertaken by families at the time.
  - Vast majority (over 86%, 123/143) had a routine eye exam (OD/MD) within 12 months of the initial assessment with us with *no concerns raised* on routine testing.

Results

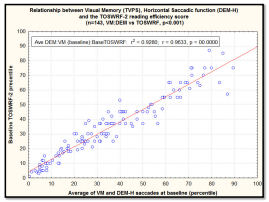

Figure 1: Relationship between TOSWRF-2 reading score at baseline and the performance of the patient on DEM testing and VM testing (TVPS). Co-efficient of determination (r^2 value) is 0.928, $p<0.001$ significance level.

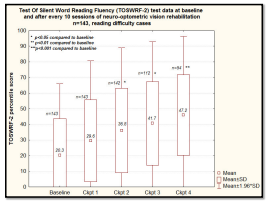

Figure 2: Change in TOSWRF-2 reading efficiency score at baseline and at each checkpoint (every 10 sessions) during vision rehabilitation. Significant effect noted at 20 session checkpoint compared to baseline.

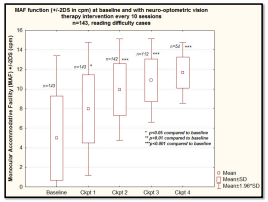

Figure 3: MAF OD (+/-2DS) change during in-office vision rehabilitation as assessed every 10 sessions. Significant change seen after 10 sessions.

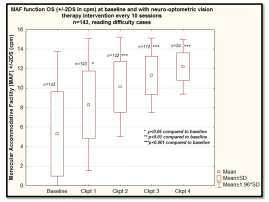

Figure 4: MAF OS (+/-2DS) change during in-office vision rehabilitation as assessed every 10 sessions. Significant change seen after 10 sessions.

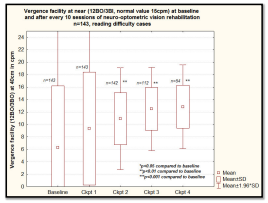

Figure 5: Vergence facility data at baseline and at each 10 session checkpoint. A significant improvement in vergence facility can be seen at the second checkpoint (i.e. the 20 session checkpoint, $p<0.05$ level).

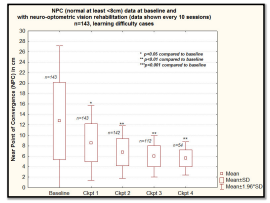

Figure 6: Near point of convergence (NPC) change during vision rehabilitation . A significant change can be seen after at least 10 sessions.

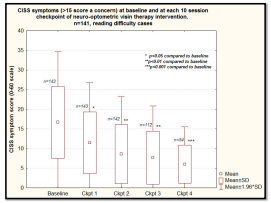

Figure 7: CISS symptom score change during in-office vision rehabilitation. A significant reduction in symptom score can be seen as early as 10 sessions of therapy to the $p<0.05$ level, with reduction to the $p<0.001$ level not occurring until 20 sessions.

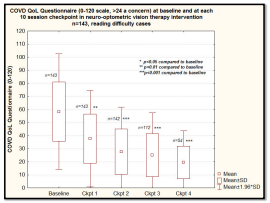

Figure 8: COVD QoL questionnaire score change during in-office vision rehabilitation. A significant reduction in symptom score can be seen as early as 10 sessions (to what appears to be a greater extent than CISS).

Results

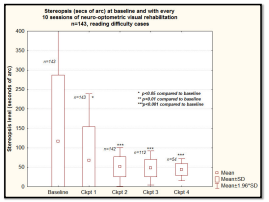

Figure 9: Change in randot stereopsis at baseline and at each checkpoint (every 10 sessions) during rehabilitative vision therapy. As can be seen, a significant effect can be seen as early as 10 sessions into therapy.

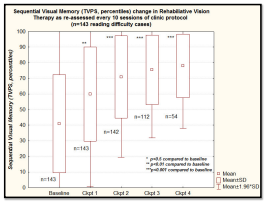

Figure 10: Change in sequential visual memory at baseline and at each checkpoint (every 10 sessions) during rehabilitative vision therapy. As can be seen, a significant effect can be seen as early as 10 sessions into therapy.

Results of note:

- TVPS global change: Average 16th at baseline to average of 65th at completion of VT program.
- TVPS Visual discrimination change: 8th percentile at baseline to average of 75th percentile at completion of VT program.
- TOSWRF-2 reading efficiency change: Average of 20th percentile at baseline to 47th percentile at completion of VT program.
- Almost all VIP and OM metrics show significant changes by 10 sessions, however TOSWRF-2 changes are only apparent at the 20 session mark indicting that OM and VIP improvements are required to occur PRIOR to reading efficiency improvement occurring.

Discussion

- IEP and controls clearly show significant differences in several binocular vision related clinical outcome measures in addition to symptom related scores as previously published by this group in Graefes[9]. In particular, this research showed that vergence facility and symptom scores predicted grouping with a 92% accuracy (Figures 11a, 11b, see right).
- There is a beneficial effect of in-office rehabilitative vision therapy on reading ability as measured by the TOSWRF-2 test with the average result taking the child from the 20th percentile range to the 47th percentile range.
- This beneficial effect is seen to some extent after 10 sessions, but continues to improve well beyond 20 sessions and even into 30-40 sessions depending on the case. However, a significant effect statistically on TOSWRF-2 scores is certainly seen at the 20 sessions mark suggesting that OM and VIP learning needs to occur prior to reading improvement.
- Given prior associations with OM dysfunction[9] and the current intervention data, it would appear sensible that children with reading based reading difficulties in particular (which make up 80% of all IEPs in Canada[1]) be thoroughly examined for OM and VIP issues.
- It appears that not only can these OM and VIP issues be remediated, but that said remediation has a cause / effect relationship to reading ability as measured on the TOSWRF-2 battery. Children with reading difficulties who complete in-office vision rehabilitation appear to achieve significant gains.

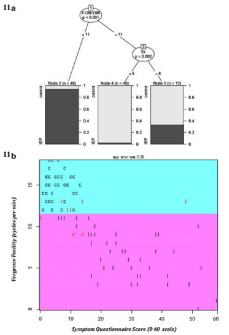

Figure 11: Prior published research[9] showing vergence facility at near as a strong predictor of IEP/Control grouping

Conclusion

- Routine eye examinations appear to be insufficient in detecting OM and VIP visual issues linked to reading difficulties.
- In-office vision rehabilitation is significantly effective in improving OM and VIP metrics, which appear to have a beneficial effect on TOSWRF-2 reading efficiency scores. There also appears to be a reasonably strong predictive relationship between visual memory, saccadic eye movements and decoding speed on the TOSWRF-2 battery.
- Although significant improvement is seen at 10 weeks (i.e. first checkpoint) in almost all OM data, statistically significant changes were not apparent in reading until the 20-session checkpoint (i.e. second checkpoint as measured on TOSWRF-2.
- A full OM and VIP evaluation (in addition to cycloplegia) is strongly advised for children with reading based learning difficulties.

References & Acknowledgements

1. Learning Disabilities in Canada: Economic Costs to Individuals, Families & Society (2002). Commissioned by the Learning Disabilities Association of Canada and conducted by the Roeher Institute.
2. Grisham et al (2007). Visual skills of poor readers in high school. Optometry, 78 (10), 542-549.
3. Young et al (1994). Visual factors: A primary case of failure in beginning reading. J Optom Vis Dev., 32(1), 58-71.
4. Kulp et al (1996). Visual predictors of reading performance in kindergarten and first grade children. Optom Vis Sci., 73(4), 255-262.
5. Maples WC (2003). Visual factors that significantly impact academic performance. Optometry, 74(1), 35-39.
6. Granet et al (2005). The relationship between convergence insufficiency and ADHD. Strabismus, 13, 163-168.
7. Borsting et al (2005). Measuring ADHD behaviours in children with symptomatic accommodative dysfunction or convergence insufficiency: A preliminary study. Optometry, 76(10), 588-592.
8. Maino DM (2010). Editorial: The binocular vision pandemic. J Optom Vis Dev., 41(1), 6-13.
9. Quaid & Simpson (2013). Association between reading speed, cycloplegic refractive error and oculomotor function in reading disabled children versus controls. Graefes Arch Clin Exp Ophthalmol 251, 167-187.

Acknowledgements: We would like to thank the Government of Canada for funding (Scientific Research & Experimental Development grant , SR&ED)

Government of Canada / Gouvernement du Canada