Volume 8 | Issue 1 | March 2020

OPTOMETRY & VISUAL PERFORMANCE

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Optometrists Change Lives™ Resident Writing Competition

Beginning in 2014, the Optometric Extension Program Foundation has presented an award for an outstanding original paper submitted by an optometric resident in the field of visual performance. This year is no exception.

The award recipient will receive a scholarship for one OEP Clinical Curriculum Course. This course scholarship is valued at $2000.

What are the requirements?

- The article can be on any topic related to visual performance
- Can be a Case Report, Review Article, or Article of Discovery (research)
- Must be original, unpublished work
- Minimum length is 1500 words
- The style must follow *Optometry & Visual Performance* guidelines

Who is eligible?

- The applicant must be a full-time resident in an ACOE registered residency program in the areas of visual performance (vision therapy, vision rehabilitation, low vision, or pediatrics).

How does it work?

- Articles must be submitted to the Editor in Chief of *Optometry & Visual Performance*, Marc B. Taub, OD (mtaub@sco.edu) by June 1st.
- The winner will be selected by the *Optometry & Visual Performance* editorial board and announced by June 15th.

2020 Clinical Curriculum Schedule

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29 April - 3 May 2020
The Art & Science of Optometric Care –
A Behavioral Perspective
Location: Melbourne, Australia

29 April - 3 May 2020
The Art & Science of Optometric Care –
A Behavioral Perspective
Location: Red Deer, Alberta, Canada
Instructors: Paul Harris, OD, team doctor of the Baltimore Orioses and Geoff Heddle, OD

29 April – 3 May 2020
The Art & Science of Optometric Care –
A Behavioral Perspective
Location: Melbourne, Australia
Dr. Paul Graham, B.App.Sc Optom (Hons) FACBO

29 April – 3 May 2020
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A Behavioral Perspective
Location: Red Deer, Alberta, Canada
Instructor: Virginia Donati, OD

14-17 May 2020
VT3/Strabismus and Amblyopia
Location: Halifax, Canada
Instructor: John Abbondanza, OD

3-7 June 2020
VT1/Visual Dysfunctions
Location: Metro Boston, Massachusetts
Instructor: John Abbondanza, OD

3-7 June 2020
VT2/Learning Related Visual Problems
Location: Ft. Lauderdale, Florida
Instructor: Robin Lewis, OD

17-21 June 2020
VT2/Learning Related Visual Problems
Location: Milton, Ontario, Canada
Instructor: John Abbondanza, OD

8-12 July 2020
The Art & Science of Optometric Care –
A Behavioral Perspective
Location: Bolton, Ontario, Canada
Instructor: Virginia Donati, OD

9-12 July 2020
VT4/Expanding the Scope of Your VT Grid
Location: Red Deer, Alberta, Canada
Instructor: Robin Lewis, OD

9-13 September 2020
VT1/Visual Dysfunctions
Location: Bolton, Ontario
Instructor: Geoffrey Heddle, OD

30 September – 4 October 2020
The Art & Science of Optometric Care –
A Behavioral Perspective
Location: Boston, Massachusetts
Instructor: John Abbondanza, OD

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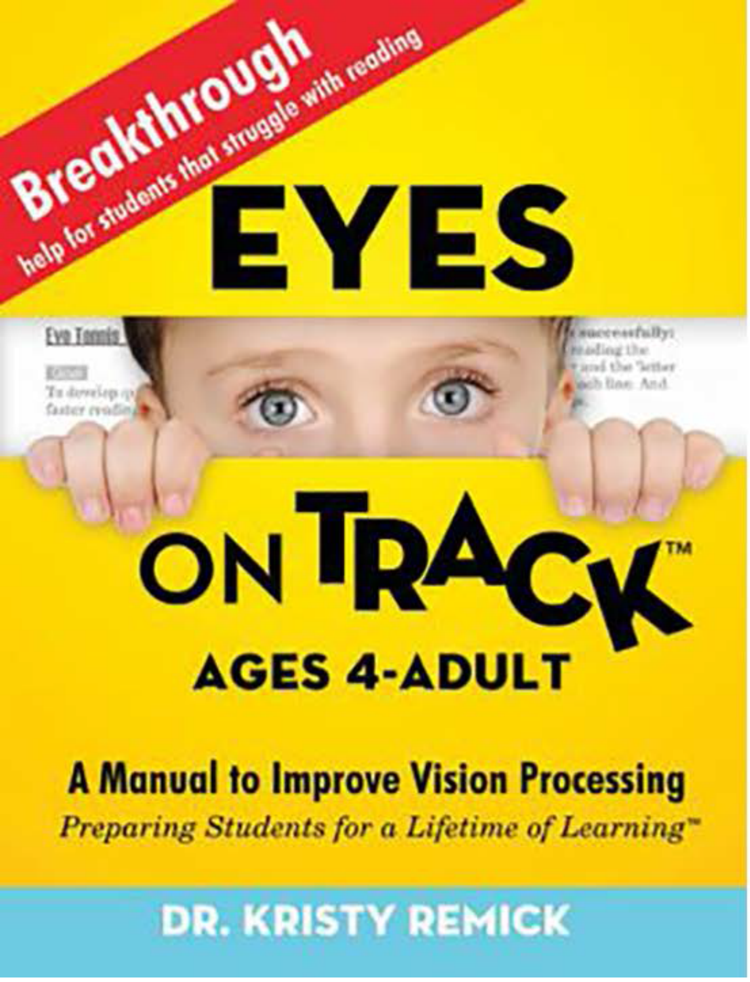

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Optometric Extension Program Foundation

OPTOMETRY & VISUAL PERFORMANCE

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All manuscripts should be submitted via the submission portal at http://bit.ly/OVPed. For more information see the Guidelines for Authors at http://bit.ly/OVPguidelines.

MISSION STATEMENT

Optometry & Visual Performance (OVP) is an international, peer reviewed journal dedicated to the advancement of the role of optometry in enhancing and rehabilitating visual performance. The mission of *OVP* is to increase the awareness and availability of clinically relevant information in functional, developmental, behavioral, and vision therapy aspects of optometry through an internet based, open access format. *OVP* is a collaborative effort of the Australasian College of Behavioural Optometry and the Optometric Extension Program Foundation.

Optometric Extension Program Foundation

OPTOMETRY & VISUAL PERFORMANCE

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Upcoming Events!
See last page of this issue.

2020 OEP Regional Congresses & Affiliated Meetings

Sports Vision
3-5 April 2020
OEP – NEC, Timonium, Maryland

COVD 50th Annual Meeting
21-25 April 2020
Toronto, Canada

VT Foundation 2020: Hands-On Therapy Training Course
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RCS: Visualization: The Critical Link Between Vision Therapy and Learning
23-24 May 2020
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CCVC
17-19 June 2020
Memphis, Tennessee

VT Foundation 2020: Hands-On Therapy Training Course
20 July – 7 September 2020
Toronto, Canada

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8-9 August 2020
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VTC AGM 2020
14-16 August 2020
Ottawa, Canada
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NORA 2020 Annual Meeting and Pre-Clinical Conference
10-13 September 2020
Columbus, Ohio
bit.ly/NORA2020

RCS: TBI: Acquired Brain Injury and Concussion Addressed
12-13 September 2020
Red Deer, Alberta, Canada

SAVE THE DATE! 3-4 October 2020
Alumni Study Group 2020
Use of Technology in VT Practices
OEP Center, Timonium, Maryland

VISIT THE OEP WEBSITE CALENDAR FOR FULL PROGRAM DESCRIPTIONS AND REGISTRATION INFORMATION!

Optometric Extension Program Foundation

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Editorial • Do You Possess Intellectual Binocularity? Have You Developed Intellectual Binocularity?

Geoff Heddle, OD • Granger, Indiana

Geoff Heddle, OD
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Optometrist, Private Practice
OEPF Clinical Instructor
Indiana University, 1998
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As optometrists, practicing from a behavioral model, we are confronted with the challenge of trying to evaluate our patient's binocular process. On the surface it might seem like an easy task. Performing a cover test, measuring phorias, or having our patients complete a Van Orden Star, etc … the list can go on and on.

The importance of binocularity, or rather the binocular process (the resolution of two disparate images) cannot be overstated. Hopefully, the values of elegant binocularity can be agreed upon as it allows humans to attain performance skills such as catching, grasping and locomotion. It also allows humans to walk over and around obstacles at a greater speed and with more assurance.

Observing, evaluating, and understanding our patient's binocular process affords us the ability to understand how they may, or may not, successfully operate in their world on a daily basis. But is that it? Is there such a thing as 'intellectual binocularity'? Does this type of binocularity develop as a separate capacity, in a reciprocal nature with the binocular process, or as a function of the binocular process?

The term intellectual binocularity was presented at this past year's Clinical Confer-ence on Vision Care, by Dr. Greg Kitchener. Dr. Kitchener was referring to a metaphor that British philosopher Jonathan Glover had conceived. Glover had said that, 'if we want to understand what sorts of beings we are in depth, we need to achieve intellectual binocularity.'

Glover further detailed this metaphor by saying that having two eyes that integrate slightly different information about one scene to achieve visual depth perception, being able to see ourselves through two fundamentally different lenses (interesting choice of words from a non-optometrist!), and integrate these two sources of information, can give us a greater depth of understanding ourselves.

What are these "two fundamentally different lenses" that Glover speaks of? Is it the ability to see ourselves as either figure, or ground? Is it that simple or that complex?

What about assessing our patient's binocular intelligence? How do we do that? It was mentioned, by Dr. Kitchener, that it might be in our observation if our patients can see the duality in things. The example that was readily described was the simple idea of observing our patients' responses during visual acuities. We ask, "What is the lowest line of letters that you can see to read?" Assuming they have an acuity of 20/20, do they read that line first? Do they start at the 20/60 line?

If they do not possess acuity of 20/20, do they say the bottom row, yet are unable to read it when asked? The question of what the lowest line of letters that can be seen to read is asking the patient to process multiple concepts simultaneously. Does their ability, or inability, allow us to make assumptions of their intellectual binocularity?

This is indeed an example that is easily understood by the optometrist, in an opto-metric setting. Is there a non-optometric setting that might allow us to become aware of one's intellectual binocularity? If you answered, "YES!"? Well, you just won a solar powered flashlight! Congratulations!!

Article • Effect of Aerobic Exercise of Three Different Intensities on Intraocular Pressure

Ryan Bulson OD, MS • Pacific University College of Optometry • Forest Grove, Oregon
Shawn Henry, PhD • Pacific University College of Arts and Sciences • Forest Grove, Oregon
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ABSTRACT

Background: Previous studies have demonstrated that aerobic exercise is accompanied by an acute reduction in intraocular pressure; however, much of this work suffers from methodological flaws and/or poor description of experimental parameters. The purpose of this study was to determine the acute effects of aerobic exercise of varying intensity on intraocular pressure.

Methods: Twenty-five volunteer participants with normal intraocular pressure (17.17 ± 3.85 mmHg) completed the study. Each participant completed a standardized step test to estimate maximal oxygen uptake, which was used to prescribe individualized treadmill speeds representing three exercise intensities (95%, 65%, and 45% maximal oxygen uptake). In a random and repeated design, participants completed 2.0 km at each intensity. This experimental design isolated power (exercise intensity) as the variable of interest, while holding total work constant for each condition (2.0 km). Baseline intraocular pressure, heart rate, and blood pressure were measured prior to each exercise intensity and again at time 0, 5, 10, and 20 minutes post-exercise.

Results: Aerobic exercise using individualized treadmill speeds equivalent to 95%, 65%, and 45% of estimated maximal oxygen uptake significantly reduced intraocular pressure for all intensities relative to baseline ($p<0.01$). The 95% intensity showed a more significant intraocular pressure reduction than either the 65% and 45% intensities ($p<0.001$).

Conclusion: All exercise intensity levels were associated with an acute reduction of intraocular pressure with higher intensities demonstrating a larger reduction in intraocular pressure. Further study is needed to determine the duration of intraocular pressure reduction following exercise at different intensity levels.

Keywords: exercise, glaucoma, heart rate, intraocular pressure, maximal oxygen uptake

Introduction

Glaucoma represents the second leading cause of blindness worldwide behind cataracts.[1] The most common form of glaucoma, primary open-angle glaucoma, is an incurable progressive optic neuropathy characterized by death of the retinal nerve fiber layer ganglion cells. In primary openangle glaucoma, optic neuropathy is associated with visual field constriction and nerve fiber layer thinning in the presence of open angles on gonioscopy and elevated (>21 mm Hg) intraocular pressure.[2-4] While the exact mechanism of primary open angle glaucoma is not fully understood, it is well established that reduction of intraocular pressure, most commonly through either pharmacological or surgical means, can slow progression of the condition.[5-6] As such, lifestyle modifications that can reduce intraocular pressure represent an exciting therapeutic opportunity in eye care.

Management of many chronic diseases, such as diabetes and hypertension, includes lifestyle modification. One of the most common lifestyle modification recommendations for chronic disease is to increase physical activity.[7] Consistent with these recommendations, clinicians may consider counseling patients with primary open-angle glaucoma to increase physical activity as part of the health management plan; however, clinicians may be unclear as to what type of physical activity recommendations are most beneficial for reducing intraocular pressure, which is problematic because intraocular pressure is influenced differently depending on the type of physical activity. For example, static or isometric activities, such as hand gripping and weightlifting, have been associated with an acute rise in intraocular pressure, which returns to baseline within minutes once the activity is discontinued.[8] In fact, intraocular pressure may increase markedly during weightlifting, particularly when the participant holds their breath during the exercise. Vieira[8] observed an intraocular pressure rise of 5 mm Hg or more in 30% of subjects, with 2 of the 30 subjects experiencing an intraocular pressure increase of 10mmHg or more during a bench press activity when subjects held their breath during the last repetition. Even when utilizing a normal breathing pattern, 21% of subjects demonstrated an intraocular pressure increase of 5 mm Hg or more during the bench press activity. Similarly, several yoga postures, including Adho Mukha Svanasana ("downward facing dog"), Uttanasana ("forward bend pose"), Halasana ("plow pose") and Viparita Karani ("legs up the wall pose") have been associated with significant increases in intraocular pressure in both healthy individuals and those with glaucoma.[9] After assuming Adho Mukha Svanasana ("downward facing dog") for one minute, healthy subjects' intraocular pressure increased from 17 mm Hg to 29 mm Hg, while those with glaucoma increased from 17 mm Hg to 28 mm Hg. In a different study by Baskaran,[10] healthy subjects who assumed an advanced Sirsasana (headstand pose) showed a 2-fold increase in intraocular pressure for the duration of the posture. Thus, when considering physical activity recommendations with the goal of reducing intraocular pressure for patients with primary open-angle glaucoma, clinicians should use caution with including activities such as weightlifting and yoga.

Several studies have demonstrated a reduction in intraocular pressure associated with aerobic cardiovascular activity, which supports aerobic exercise as a potential management strategy for patients with primary open-angle glaucoma.[11-22] This effect has been observed for subjects who are young and elderly, sedentary and active, and with normotensive pressure and those with ocular hypertension or glaucoma.[22] For example, Najmanova et al.[11] recently investigated the effect of aerobic exercise on intraocular pressure for healthy, but sedentary young adult subjects. Immediately following moderate exercise on a bicycle ergonometer, intraocular pressure was reduced significantly relative to the subjects' resting baseline by approximately 18%. Similarly, Esfahani assessed the acute effect of a pre-programmed treadmill exercise program on intraocular pressure for a cohort of older subjects with suspected coronary artery disease.[12] Five minutes after completing the exercise program, intraocular pressure was reduced significantly by approximately 15%. Thus, aerobic exercise of mild to moderate intensity appears to acutely reduce intraocular pressure by a statistically and clinically-significant degree.

The effect of aerobic exercise of differing intensities has also been a topic of interest in ophthalmic literature. In a study by Qureshi,[13] both healthy subjects and those with glaucoma showed significant reductions in intraocular pressure during walking, jogging, and running, with the more intense exercises showing a more significant reduction in intraocular pressure relative to baseline. This study did not control for the variable amounts of work performed in during trial, which differed considerably. In a follow up study, Qureshi[14] confirmed that increased exercise intensity was associated with larger reduction in intraocular pressure in young, healthy, but sedentary male subjects. Conte et al.[15] compared the effects of a continuous moderate intensity exercise session versus a high intensity interval program on intraocular pressure for healthy, physically active young adult subjects. Immediately following exercise, both programs reduced intraocular pressure significantly by approximately 25% relative to baseline; however, at 10 minutes post exercise intraocular pressure had returned to baseline for the continuous moderate intensity group, while intraocular pressure remained significantly reduced for the high intensity interval group. As such, based on previous studies, higher intensity aerobic exercise may provide additional benefits in either magnitude or duration relative to low or moderate intensity exercise.

The purpose of the present study was to determine the acute effect of three different exercise intensities corresponding to 95%, 65%, and 45% of estimated maximal oxygen uptake on intraocular pressure in young, healthy subjects. Duration of effect was not assessed as part of this study. Based on previous studies, the authors hypothesized that intraocular pressure would be significantly reduced for all exercise intensities relative to baseline and that reduction in intraocular pressure would be associated with exercise intensity, that is, the higher exercise intensities would correspond to larger reductions in intraocular pressure relative to baseline.

Methods

Twenty-five healthy but sedentary young adults (10 male, 15 female; 20.40 +/- 1.10 years of age, 170.38 +/- 8.50 cm stature, 69.05 +/- 15.16 kg mass) with normal intraocular pressure (17.2 +/- 3.9 mmHg) participated in the study. Participants had no known diagnosis of ocular hypertension, glaucoma, or other ocular pathology. Participants were asked to avoid caffeine and exercise for at least five hours prior to the study; they also did not wear contact lenses for the duration of testing. This study was approved by the Pacific University Institutional Review Board (IRB 083-17).

Following completion of informed consent, baseline heart rate, blood pressure, and intraocular pressure were measured following a 15 minute seated rest period. Participants then completed the Queens College Step test to attain their estimated maximal oxygen uptake.[23-24] For the Queens College Step test, subjects stepped up and down on a step 41.25cm high for 3 minutes at a cadence of 24 steps/minute for men and 22 steps/minute for women. Cadence was maintained via an electronic metronome set at 96 beats per minute for men and 88 beats per minute for women. After a 15 second trial to adjust to the cadence, subjects maintained the stepping routine for 3 minutes. Within 5 seconds of completing the 3 minute step trial, heart rate was measured for 15 seconds while standing and multiplied by four to determine the recovery heart rate in beats per minute. This recovery heart rate value was used to calculate the estimated maximal oxygen uptake as follows: for men, estimated maximal oxygen uptake = 111.33 – (0.42 x recovery heart rate); for women, estimated maximal oxygen uptake = 65.81 – (0.1847 x recovery heart rate). The American College of Sports Medicine metabolic equation for running was used to determine treadmill speed based on each individual's estimated maximal oxygen uptake as determined by the Queens College Step test. Per the American College of Sports Medicine Resource Manual for Guidelines for Exercise Testing and Prescription, maximal oxygen uptake running = resting component + horizontal component + vertical component or maximal oxygen uptake running = 3.5 + 0.2 (speed) + 0.9(speed)(grade). Treadmill speed was the variable changed to achieve the exercise intensity appropriate to achieve an equivalent of 95%, 65%, and 45% of a subject's estimated maximal oxygen uptake, corresponding to low, moderate, and high intensities.[24] In a random and repeated design, participants completed 2.0 km at each exercise intensity level in a counter balanced manner. The duration of testing varied based on the treadmill speed. Heart rate was measured continuously throughout the duration of testing to ensure subjects maintained an appropriate level of exercise intensity. A running average of six intraocular pressure applanation measurements were taken from each eye following the completion of the 2.0 km (time 0) using the Icare ic100 tonometer (Tiolat Oy, Helsinki, Finland) as well as heart rate, and blood pressure. Additionally, Borg's scale of perceived exertion, a subjective perceptual rating of effort, was assessed immediately upon completion of each exercise condition.[25] Borg suggested scores of 11, 13, and 15 for "fairly light," "somewhat hard," and "hard" effort, corresponding to low, moderate, and high intensity exercise, respectively. Intraocular pressure, heart rate, and blood pressure continued to be measured at times 5, 10, and 20 minutes post exercise to ensure all parameters returned to baseline before proceeding with the next exercise program. Participants rested for at least 20 minutes or until heart rate returned to baseline (± 10%) before continuing on to the next exercise intensity level. If heart rate had not reached baseline within 20 minutes, intraocular pressure, heart rate, and blood pressure continued to be measured every 10 minutes until it reached baseline. Left and right eye intraocular pressure measurements for each time interval were averaged into a single reading that was used for statistical analysis since there was no difference between eyes using a 2 factor within subjects ANOVA with intensity and eye as repeated factors. A repeated measures one-way analysis of variance with post hoc tests analyzed time 0 intraocular pressure measurements for each of the four conditions (baseline, 45% maximal oxygen uptake, 65% maximal oxygen uptake, and 95% maximal oxygen uptake).

Results

The mean estimated maximal oxygen uptake for all subjects was 47.1 mL/kg·min (+/-12.0). Average resting baseline heart rate for all subjects was 68.6 (+/- 8.7) beats per minute with an average resting blood pressure of 118 mm Hg/75 mm Hg. Heart rate immediately following completion of the exercise program was 175.8 bpm (+/17.8), 147.8 bpm (+/-19.4), and 117.7 bpm (+/-16.4) with average participant walking/running speeds of 206.1 meters/minute (m/min), 135.5 m/min, and 88.4 m/min for 95% maximal oxygen uptake, 65% maximal oxygen uptake, and 45% maximal oxygen uptake, respectively. Average Borg rating of perceived exertion was 16.1, 12.5, and 9 for the high, moderate and low intensities, respectively.

Average intraocular pressure measurements for each condition are summarized in Table 1. A two

Table 1. Summary of Subject Speed, Heart Rate, Borg Perceived Exertion, and Intraocular Pressure for Different Exercise Intensities

Intensity	Speed (m/min)	Heart Rate (beats per minute)	Borg Perceived Exertion	Intraocular Pressure Right (mmHg)	Intraocular Pressure Left (mmHg)	Average Intraocular Pressure Both Eyes (mmHg)	Intraocular Pressure % Change from Baseline (mmHg)
Baseline		69		17.6	16.8	17.2	
95% Maximal Oxygen Uptake	206.1	175.8	16.1	13.1	12.7	12.9*	25
65% Maximal Oxygen Uptake	135.5	147.8	12.5	15.1	14.8	15.0*	12.8
45% Maximal Oxygen Uptake	88.4	117.7	9	16	15.4	15.7*	8.7

* p<0.01 relative to baseline

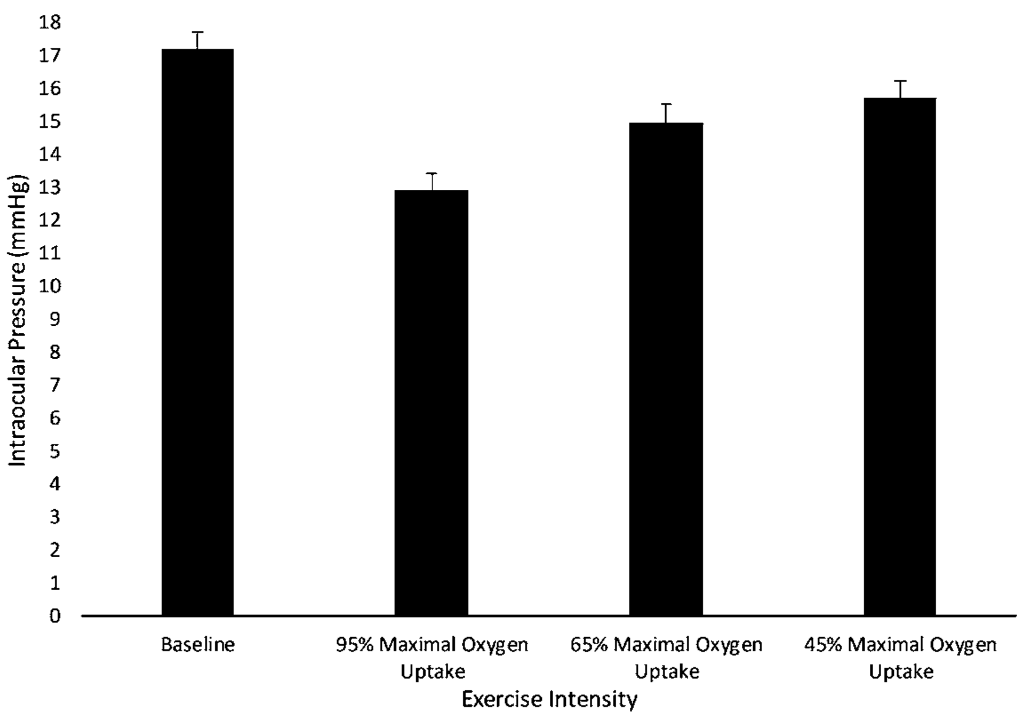

Figure 1. *Effect of Exercise Intensity on Intraocular Pressure. Plotted is mean intraocular pressure +/- 1 Standard Error of the Mean*

factor within subjects ANOVA with intensity and eye as repeated factors determined that there was no significant difference between eyes for any condition. Pearson correlation between eyes for baseline, 95% maximal oxygen uptake, 65% maximal oxygen uptake, and 45% maximal oxygen uptake were 0.941, 0.769, 0.716, and 0.866, respectively. Average baseline intraocular pressure for all subjects was 17.2 mm Hg compared to 12.9 mm Hg, 15.0 mm Hg, and 15.7 mm Hg immediately following exercise for 95% maximal oxygen uptake, 65% maximal oxygen uptake, and 45% maximal oxygen uptake, respectively, corresponding to reductions from baseline intraocular pressure of 25%, 12.8%, and 8.7%, respectively (Figure 1). Intraocular pressure was significantly reduced for all exercise intensities relative to baseline ($F_{3,72} = 30.25$, $p<0.01$). Cohen's effect size relative to baseline was 2.64, 1.36, and 0.91 for the 95%, 65%, and 45% maximal oxygen uptake conditions, respectively. The 95% maximal oxygen uptake intensity demonstrated significant intraocular pressure reduction relative to both the 65% maximal oxygen uptake and 45% maximal oxygen uptake intensities ($p = 0.001$, $d=1.28$ and $p = 0.009$, $d=1.73$; respectively). There was no significant difference between intraocular pressure for the 65% and 45% exercise intensities ($p=0.781$, $d=0.45$).

Two factor repeated measures ANOVA with intensity as repeated measure and gender as between subjects showed no significant difference between the intraocular pressure of male and female subjects for any condition.

Discussion

The current study investigated the effect of aerobic exercise corresponding to 95%, 65%, and 45% of estimated maximal oxygen uptake on intraocular pressure in a cohort of young, healthy subjects without glaucoma. Aerobic exercise at all intensities significantly reduced intraocular pressure relative to baseline. These findings are consistent with results of several previous investigations as summarized in Table 2.[11-22] Najmanova et al.[11] compared resting intraocular pressure of forty one healthy subjects before completing 30 minutes of moderate to high intensity exercise on a bicycle ergonometer corresponding to

Table 2. Summary of Literature Related to the Effect of Cardiovascular Exercise on Intraocular Pressure

Authors	Subjects	Exercise Intensity	Summary of Exercise Protocol	Change in Intraocular Pressure Immediately Following Exercise
Najmanova et al (2016)11	41 healthy young adult men and women	Moderate to High	Cycle ergonometer corresponding to an intensity of approximately 2 km per 5 min by the resistance force 12 N for 30 minutes	Intraocular pressure decrease
Esfahani et al (2017)12	patients with suspected coronary artery disease between 30-70 years	Not specified	Pre-programmed treadmill exercise program, parameters not specified	Intraocular pressure decrease
Qureshi (1995)13	14 middle aged males (7 with glaucoma, 7 without glaucoma)	Low, Moderate, High	Walking for 60 minutes, Jogging for 60 minutes, Running to volitional exhaustion	Intraocular pressure decrease for all intensities; larger reduction with higher intensity
Qureshi et al (1996)14	25 healthy sedentary young adult males	Low, Moderate, High	15 minutes on cycle ergonometer at 80%, 60%, and 40% of maximum heart rate; 7.5 minutes at 80% maximum heart rate, 10 minutes at 60% maximum heart rate, 30 minutes at 40% maximum heart rate	Intraocular pressure decrease for all intensities; larger reduction with higher intensity
Conte et al (2014)15	15 healthy young adult men	Moderate, High	Continuous moderate exercise for 30 minutes, High intensity interval training for 30 minutes	Intraoculr pressure decrease for all intensities; larger reduction with higher intensity
Qureshi (1996)16	32 sedentary males	Moderate	Cycle ergometer at a rate of on a 50 cycles/ min at a constant work load of 75 W for 60 minutes	Intraocular pressure decrease with low resistance sprints; increase with high resistance sprints
Najmanova et al (2018)17	24 healthy young women	High (anaerobic)	Maximal Exercise Test (progressively increasing speed up to 13 km/h, then increase in incline gradient until exhaustion)	Intraocular pressure increase; high variability in response
Vera et al (2017)18	26 physically active collegiate men	High (anaerobic)	Maximal cycling sprint against low and high resistance	
Vera et al (2018)19	24 physically active collegiate men and women	High	Low-fatigue and high-fatigue high intensity interval sprints	Intraocular pressure decrease with both high and low fatigue sprints
Rufer et al (2014)20	21 healthy young men and women	Moderate to High	Cycle ergonmeter with heart rate maintained at 170 beats per minute for 30 minutes	Intraocular pressure decrease

an intensity of approximately 2 km per 5 min by the resistance force 12 N. Immediately following exercise, intraocular pressure was reduced significantly relative to resting from 15mmHg to 12.3mmHg, corresponding to an intraocular pressure reduction of 18%. Similarly, Qureshi[13] observed intraocular pressure reductions of approximately 16% and 25% after completing 60 minutes of walking and jogging, respectively, for 7 middle aged subjects without glaucoma. In the same study, patients diagnosed with glaucoma showed higher intraocular pressure reductions relative to baseline with approximate reductions of 23% and 33% following 60 minutes of walking and jogging, respectively. Unfortunately, the parameters of exercise intensity (e.g. distance, pace, heart rate, maximal oxygen uptake) were not controlled nor specified in this study. Regardless, the reduction in intraocular pressure following aerobic exercise stated in the literature is consistent with the findings of the present study, which showed an intraocular pressure reduction of approximately 13% and 25% for moderate and high intensity aerobic activity, respectively, for a cohort of healthy, young-adult subjects without glaucoma.

Consistent with several previous studies, a more significant intraocular pressure reduction was observed during high intensity aerobic activity relative to both low and moderate intensity exercise in the present study. Qureshi et al.[14] evaluated the effect of aerobic exercise at different 3 intensities on intraocular pressure for 25 sedentary, young-adult male subjects. Relative to baseline resting intraocular pressure, reductions of 33%, 25%, and 6% were measured 5 minutes after completing 15 minutes of aerobic exercise on a bicycle ergonometer at 80%, 60%, and 40% of maximum heart rate, respectively. Interestingly, changes in intraocular pressure did not correlate with changes in systolic and diastolic blood pressure and therefore appear to be influenced by a factor independent of blood pressure. Regardless of the underlying mechanism, higher intensity exercise appeared to provide larger reductions in intraocular pressure. In contrast, a more recent study by Conte[15] investigated whether high intensity interval training provided superior intraocular pressure reduction relative to continuous moderate exercise for a cohort of 15 healthy young-adult men without glaucoma. The high intensity interval training exercise was performed for 30 minutes with 2 minutes of walking at 50% of reserve heart rate being alternated with 1 min of running at 80% of reserve heart rate. The continuous moderate exercise required subjects to run or jog for 30 min at 60% of reserve heart rate. The resting baseline intraocular pressure was compared to intraocular pressure measurements taken immediately following the exercise, as well as at 5 and 10 minutes post-exercise. For both the high intensity interval training and continuous moderate exercise trials, intraocular pressure was reduced significantly relative to baseline immediately following exercise, as well as 5 minutes post-exercise. Intraocular pressure reductions between the high intensity interval training and continuous moderate exercise did not differ significantly from each other immediately following exercise or 5 minutes post-exercise; however, intraocular pressure remained significantly reduced relative to baseline following the high intensity interval training trial whereas intraocular pressure returned to baseline levels at 10 minutes post-exercise for the continuous moderate exercise trial. Thus, based on the results of the present study and similar previous studies, relative to low and moderate intensity aerobic exercise, high intensity exercise likely provides additional intraocular pressure reduction benefit in terms of magnitude, duration, or both.

Maximal oxygen uptake represents the maximum oxygen an individual can utilize during intense exercise and is considered to be the gold standard for expression of cardiorespiratory fitness.[26] A higher maximal oxygen uptake is generally considered to indicate better cardiorespiratory fitness. Previous work has found that sedentary individuals attained a larger acute intraocular pressure reduction than fit individuals following exercise.[22] For example, in a different study by Qureshi,[16] 32 sedentary, young-adult male subjects were divided into either a control group or experimental group that completed a 3-month supervised exercise program that included running for 1 hour in the morning and playing hockey for 1 hour in the evening, five days per week. Each subject had intraocular pressure measured before and after completing 1 hour of pedaling an ergometer bicycle continuously at a rate of on a 50 cycles/ min at a constant work load of 75 W at both baseline as well as following completion of the supervised exercise program for 3 months. At baseline, the acute intraocular pressure reductions following the 60 minute cycling exercise test were 4.18 mm Hg and 4.38 mm Hg, while after 3 month training program these values were 4.12 mm Hg and 2.69 mm Hg in control and experimental groups, respectively. Thus, while both the experimental and control groups experienced a significant reduction in intraocular pressure following 60 minutes of cycling, the more physically fit experimental group showed a smaller reduction in intraocular pressure post-exercise relative to pre-exercise levels. The mechanism by which more physically fit individuals experience an altered intraocular pressure response following exercise relative to more sedentary individuals is not clear.

Several theories have been proposed to explain the mechanism of intraocular pressure reduction following exercise.[22] Hypocapnia, that is, reduced serum carbon dioxide that results from heavy breathing or hyperventilation, has been shown to produce ocular hypotension in isometric exercise (e.g. strength training); however, in more dynamic aerobic exercise, prevention of hypocapnia with carbon dioxide addition failed to lessen the decrease in intraocular pressure.[27-28] Similarly, adrenergic stimulation as an underlying mechanism for exercise induced ocular hypotension has been discounted as the use of adrenergic beta blockers during exercise did not prevent hypotension. Martin et al.[29] found that an increase in colloid osmotic pressure related to capillary ultrafiltration (e.g., dehydration of the eye through osmotic changes in the retinal and uveal vasculature) correlated closely with acute intraocular pressure reductions during exercise and therefore has been proposed as a likely mechanism for exercise induced hypotension.

There are several limitations in the current study that should be considered in future work. First, the iCare tonometer may be influenced by corneal thickness, a parameter not assessed in the current study.[30] Secondly, the sample size of the current study is relatively small and consisted of young, healthy subjects. Future studies should seek to investigate the effects on patients with glaucoma or those at higher risk for developing the condition. Third, although the authors sought to minimize a fatigue/training effect by allowing ample rest time between trials as well as utilizing a counter-balanced randomization process, it is possible that previous trials may influence subsequent trials in a repeated measures design. Fourth, while previous work has shown the accuracy of prediction of the Queens College Step Test to be +/- 16% of the measured values, no actual gas exchange was measured during the current study.[23] Measurement of maximal oxygen uptake in a laboratory setting requires specialized equipment and, as such, the step test provides a reasonable approximation of maximal oxygen uptake. Finally, there is a well-established diurnal change in intraocular pressure, particularly during sleeping hours, which was not controlled for in the current study.[31-32] Future studies in this area should attempt to collect data at the same time each day to better control for intraocular pressure fluctuations related to diurnal variation. While not specifically evaluated in the current study, the duration of effect should be a focus of ongoing research in this area as previous work has demonstrated a wide range of duration of effect ranging from as little as 10 minutes to nearly 1.5 hours, depending on various factors, such as resting/baseline IOP, presence/absence of glaucoma, and exercise intensity.[14-15]

Despite the limitations above, the results of the present study suggests that aerobic exercise should be considered as part of the therapeutic options for patients with glaucoma or those at risk of developing the condition who are interested in lowering their intraocular pressure through non-pharmaceutical or non-surgical means; however, more investigation is needed to determine the long term effects of aerobic exercise on IOP and subsequently, glaucoma progression. Higher intensity aerobic exercise produces more significant reductions in intraocular pressure and therefore may be more advantageous for patients interested in lowering their intraocular pressure, however, many patients with glaucoma, which tends to affect older populations, may not be physically capable to performing high intensity exercise. It is notable that statistically and clinically significant intraocular pressure reductions of 8.7% and 12.8% were observed for the low and moderate intensity exercise programs, so even light cardiovascular activity such as walking or light jogging are likely to confer intraocular pressure reduction benefits for patients who are physically capable. It is possible that the effects of small bouts of activity throughout the course of the day, for example taking the stairs rather than an elevator or choosing a parking spot further away from the building entrance, may produce transient reductions in intraocular pressure over the course of an entire day, which may cumulatively be significant in reducing average daily intraocular pressure, the only modifiable risk factor for glaucoma at present.

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Article • Pediatric Hyphema with a Secondary Bleed: Case Report on Childhood Trauma

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ABSTRACT

Background: Ocular trauma in childhood can have a lasting effect and is usually preventable with proper education and eye protection. A common manifestation of ocular injury caused by compressive or blunt force trauma is hyphema, which is blood accumulation in the anterior chamber following a tear in the iris or angle structures.

Case Report: A 6-year-old white male was referred by the local emergency department following a close-range airsoft gun shot to his left eye. He presented with extreme pain, photophobia, and blur. Visual acuities were attempted, but unsuccessful due to poor patient cooperation. Intraocular pressure was 12 OD and 9 OS. 3^+ bulbar conjunctival injection, 2-3^+ corneal edema greatest temporally, a small corneal abrasion, and a microhyphema were present. Seidel sign was negative. After 2 days of management, corneal abrasion had resolved, however, the hyphema had a secondary bleed filling 75% of the anterior chamber. A B-scan confirmed that the retina was flat and no vitreous hemorrhage was present. The patient was referred to pediatric ophthalmology and an anterior chamber washout was performed. Final visual acuity was 20/30.

Conclusions: Childhood traumas related to sports and recreation are often preventable with proper eye protection. These ocular traumas pose a challenge for eye care providers, as children are often more difficult to examine and treat. As pediatric providers, we must educate patients, parents, and coaches on the importance of prevention.

Keywords: hyphema, pediatric trauma, secondary bleed

Introduction

According to an 8-year study, 5,615,532 individuals with ocular injuries reported to emergency departments in the United States; 28% were in those under the age of 20.[1] Another 22 year retrospective study reported an average of 19,209 pediatric ocular sports and recreational related ocular injuries reporting to the United States Emergency Departments annually.[2] Pediatric ocular injuries often occur at home and are related to sports and recreational activities. Common non-penetrating injuries include corneal abrasions, foreign bodies, ocular burns, hyphemas, subconjunctival hemorrhages, and eyelid lacerations. Individuals ages 5-25 and over 70 are at a higher risk for injuries represented in a bimodal age-risk curve.[3] It has been reported that ages 5 to 8 are at an especially high risk due to magnitude and severity of hyphema that may lead to higher long-term complications. The combination of pediatric patients having not fully developed motor and cognitive skills makes them more susceptible to ocular trauma; males have a higher risk of ocular trauma compared to females by 1.8 – 5.4:1. The risk is higher, likely due to a more aggressive nature of activities, for males as compared to females.[4]

Ocular trauma in children is often preventable with proper eye protection, especially in sports related injuries. Miller et al. reported hyphema and lacerations more commonly required hospitalization compared to other types of ocular injuries.[5] Of those reported injuries, non-powder gun related accidents required hospitalization more compared to other sports related injuries.[2] A non-powder gun is one that uses compressed air, gases, or springs to fire instead of gunpowder. Examples of common non-powder guns are Air Soft, BB, pellet, and paintball guns. The number of non-powder gun related injuries reporting to United States Emergency departments has increased by 511% between 2010 and 2012 and the trend has continually increased since.[6]

A hyphema is defined as accumulation of blood in the anterior chamber of the eye and is most often caused by a tear in the iris or an angle structure. The most common cause of this bleeding is traumatic injury from blunt or compressive forces causing injury to the vessels leading to accumulation of red blood cells in the anterior chamber. These traumatic injuries may be a result of direct impact of the ocular structures, projectiles, or as a result of an explosion. Spontaneous hyphemas are less common and are usually related to leaky, weak vessels that are formed in Sickle Cell disease or neovascularization due to ischemic conditions or neoplasms. Another cause of hyphema in pediatric patients is Juvenille Xanthogranuloma, a rare disease that usually presents in children less than 2 years of age. Visual prognosis is excellent in patients with an uncomplicated hyphema, however secondary complications such as optic atrophy, secondary glaucoma, cataracts, and corneal staining may lead to a poor visual prognosis.

Case Report

A 6-year-old white male was referred by the local emergency department following a close range airsoft gun shot to his left eye that occurred without the use of safety glasses. He presented with extreme pain, photophobia, and blur. No history of medications or allergies were reported. Visual acuities were attempted, but unsuccessful due to poor patient cooperation. Pupils were round and reactive to light with the left pupil being sluggish compared to the right. Extraocular muscle movements were smooth, accurate, full, extensive and unrestricted in both eyes with left eye pain in all gazes. Confrontational fields were attempted with poor cooperation limiting results. Intraocular pressure was 12mmHg OD and 9mmHg OS with iCare Tonometer. Anterior segment for the left eye was remarkable for 3^+ bulbar conjunctival injection, $2\text{-}3^+$ corneal edema greatest temporally, a corneal abrasion approximately 1.5mm round, and a microhyphema. No Seidel sign was observed with fluorescein. Dilated exam was difficult due to patient comfort, cooperation, and corneal edema, but a red reflex was present. 1 drop of Atropine 1% was instilled in the left eye in office. He was started on Durezol ophthalmic emulsion three times per day, 1% atropine sulfate solution twice a day, and erythromycin ointment twice a day in the left eye. He was instructed to wear a Fox shield over the left eye to prevent rubbing, especially while sleeping. He and his mother were instructed on the importance of strict bed rest and that he was to sit at a 30-45 degree angle with no activity for the next week. He was originally seen over the weekend so the patient was scheduled for a follow-up on Monday morning. He was instructed to call immediately if vision or pain worsened.

The patient returned complaining of pain and headache two days later. The patient's mother had placed a patch over his left eye, not by instruction of the doctor, so he was unaware of whether or not his vision had changed. The patient's mother reported using all drops as directed in addition to alternating Tylenol and ibuprofen orally for pain. Visual acuity was attempted, but unattainable due to cooperation. Intraocular pressure of the left eye was 37mmHg with iCare. The corneal abrasion had resolved, however, there was a secondary bleed that filled 75% of the anterior chamber in the left eye. A dilated exam was not able to be performed due to obstruction of view from the secondary bleeding, however, the retina was flat and no vitreous hemorrhage was visible on B-scan. Anterior segment photography was attempted, but images were unobtainable due to cooperation of the patient. The patient and mother were given the option of going directly to the local emergency department and waiting for on-call ophthalmology for hospital admittance or waiting for the morning to be seen by the pediatric ophthalmology outpatient clinic. After a long discussion, the mother elected to wait until the next morning and to continue strict bed rest at home. He was instructed to discontinue Erythromycin, increase 1% atropine drops to three times daily, and only use Tylenol for pain. They were educated not to use NSAIDs due to risk of further bleeding. He was to continue with Durezol three times per day. Due to the increased intraocular pressure, one drop of Simbrinza was instilled in office and he was instructed to start use twice daily at home until the consultation with ophthalmology the next day.

The patient presented to the pediatric ophthal mology outpatient department with extreme discomfort, vomiting, and headache. Minimal testing was performed due to discomfort. Intraocular pressure was 36mmHg in the left eye with iCare. The patient was given oral Acetazolamide in office which successfully lowered intraocular pressure to soft to touch and less patient discomfort per the ophthalmologist's notes. It was reported that iCare was unable to be repeated after administration of medications. The ophthalmologist continued 1%

atropine twice a day, switched to 1% prednisolone acetate six times per day, Xalatan at night, and Dorzolamide twice a day in the left eye and planned for an anterior chamber washout for the next day.

Anterior chamber washout was successfully performed under anesthesia in the operating room of the local pediatric hospital and at the one-day post operation visit, pain and intraocular pressure had decreased. Two weeks following the surgery, the patient's final visual acuity was 20/30 and unfortunately he was then lost to follow up.

Since the patient was lost to follow up, important elements to monitor for further complications were not performed. Once the hyphema has been cleared, gonioscopy should be performed to monitor for angle recession and iridodialysis. The patient should continue to be monitored for secondary complications, such as glaucoma and optic atrophy with intraocular pressure, dilated fundoscopy and optical coherence tomography. In addition to monitoring ocular health, a discussion about safety glasses and prevention methods with the parent and patient would also be included in follow up.

Discussion

Although medical management is similar to adult cases with the focus being on supportive treatment and preventing a secondary bleed, there are some stark differences between pediatric and adult hyphema. Strict bedrest at a 30-45 degree angle to promote blood settling and decrease the risk of secondary bleeding is crucial. Children tend to be more active compared to adults, so consider hospitalization to ensure bed rest. Hospitalization may be additionally beneficial due to the ability to monitor more closely for intraocular pressure spikes, secondary bleeding, and corneal staining. In addition to limiting activity, topical treatment with cycloplegics and steroids can be used for pain and inflammation management. Additionally consider oral anti-emetics and a Fox shield for nausea and protection respectively. Intraocular pressure lowering medications may be used as needed with topical beta blockers, topical carbonic anhydrase inhibitors, or oral carbonic anhydrase inhibitors being the accepted modalities for pediatric patients. Although some sources suggest it is safe to use alpha-2 agonists in children over the age of 5, some ophthalmologists and optometrists, including the ophthalmologist treating the patient in this case, typically avoid alpha-2 agonists due to central nervous system side effects in patients under the age of 8. In the past, antifibrinolytics have been used and thought to prevent secondary bleeding, but have a high incidence of side effects.[7] In more recent studies, antifibrinolytics, aminocaproic acid (ACA) and tranexamic acid (TXA), have been said to be effective in the prevention of rebleeding without prevention of other complications. Topical ACA may be an alternative when steroids are contraindicated.[8] The prevention of secondary bleeding has historically been the main goal of hyphema treatment due to the increased risk of visual impairment. In this particular case, secondary bleeding did not have a detrimental effect on final visual acuity. Final visual acuity relates more to type and severity of initial injury with open globe injuries significantly relating to poorer visual outcomes.[4]

A secondary bleed is a result of a clot being lysed from the bleeder vessel that it has blocked and typically occur 2-7 days after the initial injury.[8,9] Re-bleeding can be prevented by limiting eye rubbing and movements of the patient and also with the use of pharmaceutical agents, such as corticosteroids or antifibrinolytics.[8,9]

Young patients are especially difficult to examine when in pain as there is limited ability to reason or negotiate with them compared to adults. When evaluating pediatric patients, consider the risks involved in attempting examination elements with poor cooperation versus the benefits. It is suggested to approach pediatric ocular traumas in a systematic manner; rule out and manage other injuries, differentiate between open and closed globe injuries, and attempt to evaluate vision in both the injured and uninjured eye, and seek an additional opinion if treatment does not respond as expected.[5]

A thorough case history is required as it is important to rule out any suspicion of abuse. A systematic review in the United Kingdom found that all kids presenting from physical abuse with ocular injuries presented with a subconjunctival hemorrhage and urged pediatric physicians to be suspicious of non-accidental injuries. One third of patients in that study were not identified as abuse victims on initial presentation.[10] In this same study, they found traumatic hyphemas from non-accidental injuries caused by corporal punishment and were more common in 4-14 year old patients.[10]

When treating children after trauma, it is important to educate both the child and the parent on long-term effects and the risks of complications in the future, including cataracts and the increased risk of glaucoma. About 40% of traumatic cataracts following traumatic hyphema require surgery within 2 months following the injury and present as early as 2 weeks post injury.[11] Encourage regular dilated exams and gonioscopy to monitor for delayed complications even after resolution of the hyphema. Young children do not realize their compliance and cooperation may affect their future, so you must ensure the parent realizes the seriousness of this condition in order to support the management plan outside of your office.

Although being proficient in the examination and treatment of pediatric trauma is important, the optimal treatment is prevention. In a retrospective study by Lee and Fredrick, out of 71 cases reporting eye protection status in non-powder gun related injuries, only one patient was purposely wearing sunglasses for protection, demonstrating the lack of public knowledge of the importance of safety glasses when using these devices.[2]

Optometrists are well trained and qualified to manage complex hyphema cases. However, as in the case presented above, an uncooperative child with a secondary bleed may require an exam under anesthesia. This can be considered to ensure a thorough posterior segment evaluation. Surgical intervention is warranted in 5-7.5% of cases.[8]

Conclusion

Although traumatic hyphema in children is uncommon, there may be serious long-term complications including glaucoma, optic atrophy, and decreased vision. Evaluation in children is often more challenging given poor cooperation when children are in pain. Health care providers should use precautions to avoid further injury while evaluating young patients whom are not cooperating; judgments should be made in weighing what tests are most important and most effective in these situations and which tests can be sacrificed.

Ocular injuries are often preventable with proper protection; parents and coaches should become more aware of the importance of prevention through protective eyewear. Optometrists can help by discussing the importance of safety eye wear as well as the dangers of eye injuries, especially with non-powder guns, during comprehensive vision exams.

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Basic to Vision is the Concept of the Effector Process

Equally basic is the realization that the covert processes are always precedent to the Overt. The concept of the covert movement pattern is essential to the understanding of any activity, particularly the elaborate Central Nervous Activity that is now labeled "VISION."

Vision is an Emergent from All the Sub-Systems

The efficiency of vision and its effectiveness depends on the effectiveness of the sub-systems. This is particularly true of the covert movement patterns. The overt manifestation is an extremely small part of that operational entity called "reach, grasp and release." Studies of the "reach, grasp and release" totality have been made by the observation of performance in such procedures as "dangled bell." The concept is equally applicable to that over-covert performance known as 'reading.' If the entirety of the reach, grasp and release concept is to be realized, further investigations must be made.

Vision as an Emergent Applies to Any Level Being Considered

It is important to take into consideration the various strata of derivatives being utilized .at any moment. Basically, vision, as a meaningful activity, is of necessity a derivative of derivatives, each leading to a higher level. The levels of percept and concept are indicators of these levels. Finally, the ultimate derivative is that of cognition, which leads to the formation of universals. Universals may be considered the most elaborate of the ultimate Summation of derivatives.

To attain a grasp of universals, there must be the precedent development of abstracts. These in turn are dependent on the development of discrete elements that can finally be reduced to the single response to a single sense stimulus. The single stimulus may alert the organism, but alone it is almost meaningless to the organism. This is a description, in reverse, of the process by which man can ultimately think. Also, it is description, in reverse, of the significance of the reach, grasp and release mechanism.

The Documentation of the Physiologic Sequence

Dr. Arnold Gesell noted and described the child seeing a pellet with his eyes before he could pick it up with his fingers, or the earlier palmar groping. The phenomenal behavior of a child watching the dangle bell procedure reveals reach, grasp, and release on a relatively simple task demand. This phenomenal behavior is now considered to be related to the child's visual maturity. We accept this as probable. There has been less consideration given to the thinking processes that must lie behind the instructional level of the educative process.

Reach, Grasp and Release in Visual Behavior

In visual behavior, the child must be able to reach, visually, for an object in space, grasp it, and release it to be free to reach for another object in space. In the formation of an idea, the child must be able, mentally, to reach for the constituent fragments of an idea, grasp them, assemble them, then release them in order to be free to reach for the next section. This must continue in the development of productive thinking.

A Visual Problem is a Limitation in Learning

This would seem to be why, likewise, a visual problem would be an interference in some level of the reach, grasp and release process. Edith Meyers and Ward Halstead have stressed the fact that these elaborate processes are the most fragile. They are, likewise, the ones for which man is least fitted by his biological inheritance. The elaborated processes have a far greater liability to destructuring of the derivative amalgam by the environmental stresses. This idea would apply to the developing child, the early maturing adult, or the aged.

The Levels of Derivatives

Harmon states that the developing processes are varying levels of derivatives. In fact, the varying levels of reach, grasp and release could be diagrammed in relation to the levels of derivatives. An early level of the reach/ grasp/release entity is the awkward grasping of the hand, directed by the "eye" in conjunction with the total balancing mechanism. The delay in developing the release mechanism is well known. The amount of information stored in the "stream of consciousness" at this level would be very small. The related lattices of experience would be very simple.As the balancing mechanism develops, the overt graspings decrease, the fine movement with the index finger and the opposed thumb become related to the intricacy of the lattices of experience. Eventually, more precise, exact and perfectly timed performance evolves with the efficiency of the reach, grasp and release processes.

Reach, Grasp and Release in Language

It is not difficult to extrapolate this idea of the reach, grasp, release involved in the fine movements of the index finger and thumb to the evolution of more and more precise use of the structure of the language symbols. Language, with its symbols both spoken and written, provides the transport for the enlarging of the mechanics of the elaborating memory lattice structure. As the organism matures, it can use the configurations of the written or printed word as the tempero-spatial-chemico affinity that sets the stage for the elaborating memory lattices, carries the mechanics of reach, grasp, release into a coordinated process which is wholly covert and within the stream of consciousness, from which it can be externalized as an overt movement quantificable in the eye itself, as alignment and accommodation.

The Elaboration of the Covert

With further elaboration of the covert patterning, the dependence upon the overt is reduced. Speech and audition take their place in the development or elaboration within the covert patterning, in the stream of consciousness. This is replaced in its ascendency by the visualization processes, which, in time, becomes independent of all the other derivative processes.

It is at this level of transcendence of all overt processes that the tempero-spatial-chemico affinity processes can be freed from and lose dependence upon, the printed symbols. The organism is lifted by its ultimate powers of elaborations of lattices within the stream of consciousness, is divorced from time and space, and is able to use the reach, grasp and release principles to reach for the elements of an idea, that are within an elaborate experience lattice, can combine it with another lattice in a total grasp, and so increase its ability to Think; then release this to again reach for elements of a further elaborated process. In this way is developed the elaborate reach, grasp and release process in the realm of productive and original thinking.

The Physiological Basis of Reach, Grasp and Release

The growing child must, of necessity, proceed from what he has learned to do with his two hands to the manipulation of what is not within reach of his hands. This manipulative movement is just as truly a part of the overt behavior as the selection of extension and contraction of muscle to control the index finger and opposed thumb. The extended prehension is part of the slow movement out from himself. From playroom to classroom, the extent of the reach, grasp, release process is broadened and extended so that the person can reach for the chalk, grasp the significance for using the chalk on the chalk board, release from use of chalkboard to use of pencil and paper. This relatively simple process - altho actually of great complication – can be extended to grasping the significance to himself of objects in space, release this, once again to return to the intellectual activities at hand. It has been observed that when a pre-schooler is poor in the reach, grasp and release on the observable overt level, it is possible to predict he will have trouble with symbolism in the classroom. These are both gross reach, grasp and release. When the child is brought to the printed page, the reach, grasp and release process must necessarily be elaborated. When the successive configuration of lines of type are presented, whether it be a letter, or a word, or phrases or sentences, there must be the grasp, which in turn is released to the next reach and grasp and the organism comprehends the significance and then releases it to continue to the next.

Inadequacies of Reach, Grasp and Release

Inadequacies of the reach, grasp and release entity are demonstrable even in such elemental procedures as the developmental drawings. If the child is unable to complete its corners, it is inadequate in reach, grasp and. release. The use of the personal pronoun is not an. error. The failure to complete the corners are within the organism. The child who cannot form his letters well has an inadequacy in some of the fundamental properties so essential in the visual process. The process of learning to read is supposed to continue for the first three grades. After that the child is supposed to be prepared to read to learn. Learning to read is really the process of refining the reach, grasp and release complex. The need is to elevate it above the first, second or third level of derivatives so that the organism can combine and recombine the sensory circuiting to where the reach, grasp and release process can operate on the abstract level.

The developing mind begins to relate its own elaborated experience lattices with those of a vicarious organization grasped from a printed page. The ideas of others are conveyed to the reader in such a climate that there is a tempero-spatio-chemico affinity which permits the combining of various lattices of experience, which again can be released. This release makes possible the reaching for more of the vicariously transmitted experiences. In this way is established the climate for further recombining of experiences when the child has reached the instructional and maturational level that permits him to read to learn. Throughout the whole process, there is a constant and essential process of reach, grasp and release.

From the foregoing, it would seem that reach, grasp and release is vital to the development. of the visual process. The baby is strapped to the chair, who "picked up a pellet with his eyes before he did with his fingers" is in the early stages of developing the reach, grasp, release complex. The person in deep thought may have his eyes open yet sees nothing while he is in the process of combining and re-combining the elaborated lattices of experience to produce new ideas. These developed ideas may be conveyed to others of a comparable elaborated reach/grasp/release process. Man can then communicate with man on the level of the development of the reach, grasp and release mechanisms present in each, the communicator and the communicatee.

The Value of the Concept of the Four Circles

Visually, the most primitive organization in the ontogenetic recapitulation of the phylogenetic development is that of alignment and the responses to the pull of gravity. The groundwork of response to gravity must be considered prodromal to the organism's organizing level that will permit the emergence of Vision. When the infant responds to radiant energy for the first time, then the element of Vision has its beginnings. The response to gravity is the basic foundation for the infant's response to radiant energy - or that particular band of radiant energy for which he has specialized receptors in the retina.

The newborn makes its first attempt to align the four quadrants of the retina that there may be an equal light distribution over the total retina. This is the process described by McCullough as "reducing the vector to zero." It is, likewise, the first reach! The first startle response would appear to be the first grasp! The shutting of the small eyes in protest would be the first release! The developing stream of consciousness will shortly permit the reach, grasp and release to take place with the eyes remaining open. A new element is added to the emergent Vision when the infant identifies its mother's breast or the feeding bottle, as well as the various radiant energy modulations throughout the room. In time, as the rapidly myelinting brain organizes its experience lattices, it extends its organization of experience upon experience in the stream of consciousness.

Protopathic Origins of the Reach/Grasp/Release Entity

The very young infant has for its early emergent Vision little more than the integration of the foundational response to gravity and the protopathic alignment responses with the resulting beginnings of centering and identification.

With the growing awareness, comes the first speech-auditory response. The child discovers that the cry of anger brings comfort, dryness and food, out of the space world he is beginning to manipulate. He is reaching with his cry, grasping it with comfort and releasing from it with sleep.

All the elements of the emergent Vision come into aggregation. All the elements are essential, all are necessary, yet none of them ARE the Emergent. However, the Emergent is dependent on the development of all of the elements. The Emergent is that intangible thing with so many meanings that it defies description. If there is an acceptance of Herrick, then actually that Emergent is what has been called Mind. This is acceptable only if there is a subscribing to the statement that "Mind is not something that I HAVE mind is something that I AM."

The development of any of the physiological or neurological processes in any of the sub-systems can be studied in isolation. However, unless there is an understanding of the value to the organism of the integrating of the derivatives of the various contributing modalities of the close energy sequence and their integration with the circuiting of other sensory modalities, then the understanding of the value of each sensory modality in Vision is lost. In each element there is a reach, grasp and release component. It is obvious in the balancing mechanisms with their thrust and counter-thrust; it is present in the speech-auditory circuiting; it is visible in alignment and is implicit in identification. It must be emphasized that, fundamentally, reach, grasp and release has its origin in and its extension within that unknown realm of human behavior, the stream of consciousness.

The overt can reveal operations within the covert. As the reach, grasp and release processes are considered in the stair stepping responses to the dangle bell procedure, or the fumbling thumb and index finger manifestation or the inadequacy of shifting of gaze from near bell to object across the room, there is being investigated externalized overt performances which reveal inadequacies of covert reach, grasp and release processes.

These investigations permit an evaluation of the probable level of performance. They permit the clinician to realize whether grasp is good, reach adequate or release smooth. These are all elements of the process called Mind. They are controlled by the intangible total organismic process labeled, for lack of a better, the Stream of Consciousness. They are overt manifestations of the magnitudes of experiences. This is true at any age, whether it is the baby who has not learned how to release from the side of the crib or the child who cannot "make a corner" or the college student whose ability to grasp the essentials of a subject are inadequate and who is slow to reach for new meanings, or the adult who is unable to release one idea to reach for another within the timing of his stream of consciousness. Whoever and at whatever age that the individual loses the essence of the vicarious thought or the original idea that would have been his, there is manifestation of the inadequacy of the reach, grasp and release processes, that had they been adequate, he would not have failed to grasp the author's thought or to do the original creative thinking he might have done.

Summation

It would appear from the notions here set forth that reach, grasp and release is vital arid essential to the development of the Emergent Vision at any level of experience aggregation. To limit the concept of reach, grasp and release to the overt manifestations would seem to enormously underestimate the universality of the process, entity, sequence or whatever label can be chosen for an essential element of control of any behavior, from the first,elemental reach/grasp/ release on exposure to radiant energy, to the thought processes of the original thinker. This understanding of the universal pervasiveness of the reach/grasp/release entity would further or hinder the understanding of the properties of that deterioration from optimal behavior carrying the label of a Visual problem.

Probably it is extending the idea too far, but for a point of emphasis it is allowable, to hypothesize that the magnitude of a visual problem is co-variant with the degree of inadequacy of the reach/grasp/release entity, at whatever level of derivatives the task demand may make its impact on the organized lattices of experience of that individual. Reach, grasp and release being biologically protopathic in origin, and extending the processes throughout the developing organism, are likely to reflect any inadequacies occurring in the earliest stages of biological development, in greater and greater degree as the higher and higher levels of derivatives are affected. It is for this reason that investigation of the reach/grasp/release is so important in all the observable overt behaviors. It is likewise important that the realization be held that this same process is operating at the highest level of derivatives. It is this idea that gives validity to the optometric idea of enhancement.

On the assumption that a visual problem is a stress induced limitation in the operation of the fundamental reach/grasp/release complex, it "would follow that a visual problem would render less effective the formulation of the congenial climate for memory lattice development. This assumption and the resulting conclusion would hold that a visual problem limits learning. This has been a basic assumption for some time. Further extension of the notion would be that if more economical behaviors were initiated, an improvement in the total complex would follow. On the assumption that learning is essentially the product of more and more elaborated tempero-spatio-chemico lattices, when the impediment to the formation and combining of these memory collocations is either no longer present or has been significantly lessened, learning potentials should be increased.

The gradual development of a visual problem, increasing in effectiveness as the demands of the task increase, would have created a general lowering of the magnitude of learning. This would indicate the need for some sort of an acceleration process, that the person could in effect catch up with the level of total information that would have been his had the visual problem not diminished the ability to elaborate experiential lattices. The probabilities of visual enhancement enters into the consideration of the relation of the total person to any approach or consideration of complete approach to the solution of any existing visual problem.

Enhancement would be a f actor at any level of derivatives. It would be valuable in the early protopathic level of the reach/grasp/release complex and would be even more significant in that level of derivatives that permit the "grouping to a criterion" and deriving a generalization. It would be at this level where the work with school children would have its greatest significance.

The most important area of value for the good of the culture and the community as a whole, as well as the individual, would be enhancement on the derivative level of the universal. It is probable that it is on the level wherein the sought-for elimination of the peripheral-covert "verbalizing" takes place. Covert tho it may seem, there is a respectable evidence that if the investigatory apparatus is of proper delicacy, overt manifestations of verbalizing can be elicited. However, when the reach/grasp/release of idea formation is in process, although the tools are there of the symbols of the language, for it is these tools that have permitted the development, the elaboration is such that overt activity is forbidden by the sheer limited speed of neural transmission. The activity becomes, of necessity, wholly covert and the speed of the reach, the grasp and the release are in the realm of astronomic mathematics. To build enhancement of this process is to strive towards the creation of a new dimension of operation in that person. Subscribing to Herrick 's definition, one is tempted to speak of "increased freedoms in the operation of mind," or, if that term is objectionable, call it "creative thinking," or, to hold it strictly within optometric terminology, "enhanced visual abilities" and allow the term "enhanced" to be without limitation.

This seemingly irrelevant discussion points to one underlying concept. That at any level of derivatives, the basis of the approach is through the integrity, balance and rhythmic symmetry of the reach/grasp/release complex. That however elaborated may be the process, it has its foundation in the behavior of the newborn, whose living retina responded and reach/grasp/release was initiated. From that moment on, all the elaborations of the visual process had that same ineluctable factor, the complex known to us as reach, grasp and release.

When the goal is enhancement and the optometrist is thinking of the higher and more complicated processes of the visual emergent, the basis for the establishment of reach, grasp and release on a universal level is based on the effectiveness of the reach, grasp and release on the first, the primary, the overt, the protopathic level.

In summary, to quote Darell Boyd Harmon, "The development of the higher faculties in man does not excuse him from developing a good, sound, physiological operation as a base for them." It is a formula never to be forgotten, from pulling infant to wisdom weighted sage - that the basis of visual operation is a complex of reach, grasp and release.

Article • Vertical Heterophoria Treatment Ameliorates Headache, Dizziness and Anxiety

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ABSTRACT

Background: Vertical heterophoria is known to cause headache, dizziness, and anxiety, three commonly comorbid diseases. Earlier studies have shown that correction of vertical heterophoria smaller than the standard error of existing phoria tests can reduce symptoms. This study is designed to demonstrate the effectiveness of prism lenses correcting for small amounts of vertical heterophoria in reducing symptoms in patients presenting with headache, vestibular and/or anxiety symptoms, and also to demonstrate effectiveness of micro-prism lenses to diagnose vertical heterophoria.

Methods: Retrospective study of patients diagnosed with vertical heterophoria who responded to treatment with micro-prism lenses and completed survey instruments at an optometry clinic in Michigan, USA. This study included 111 patients presenting with vertical heterophoria symptoms between 07/2009 and 06/2011 who self-reported significant disability from headache, dizziness, and/or anxiety on the Headache Disability Inventory, Dizziness Handicap Inventory, and Zung Self-Rating Anxiety Scale respectively, and completed pre- and post-treatment survey instruments. Participants were treated by application of corrective micro-prism lenses (vertical prism 0.25D-2.50D) followed by 1-3 lens prescription adjustments over 8-12 weeks. Outcomes were measured by repeating survey instruments.

Results: Mean HDI score reduced from 37.55 to 22.13, effect size d = .54. Mean DHI score reduced from 38.01 to 18.68, effect size d = .72. Mean SAS score reduced from 42.13 to 34.22, effect size d = .80. No side effects reported.

Conclusions: Screening and treatment for vertical heterophoria using micro-prism lenses provided significant symptom relief for patients with headache, dizziness, and anxiety symptoms that had not responded to traditional treatments.

Keywords: anxiety, binocular vision dysfunction, dizziness, headache, micro-prism, vertical heterophoria

Introduction

Headache, dizziness and anxiety are common medical problems with significant impact on individual patients and society as a whole. The Global Burden of Disease Survey 2015 (GBD 2015) estimates that 1.5 billion people have significant headaches and 1 billion experience at least one migraine headache annually, making headache and migraine the second and third most prevalent diseases globally. Anxiety disorders are less prevalent but are estimated to affect roughly 250 million people, making anxiety one of the 30 most common disorders surveyed in GBD 2015.[1] This estimate for the prevalence of anxiety may be low: a meta-analysis of studies of anxiety prevalence estimated that 7.3% of the global population (approximately 500 million people) met the diagnostic criteria for anxiety disorder.[2] Dizziness is not assessed by the GBD but a recent meta-analysis reports that lifetime prevalence of dizziness has been estimated to be between 17-30%.[3] Care for presentations of dizziness account for at least 4% of total emergency department costs in the United States, exceeding $4 billion dollars annually.[4]

Headache, dizziness, and anxiety are diagnosed primarily based on self-reporting of symptoms and history and have multiple etiologies: similar symptoms in different patients may have completely different causes. As a result, even the most effective treatments for headache, dizziness, and anxiety inadequately reduce symptoms for a substantial proportion of patients diagnosed with these conditions.[5-9]

Efforts to understand the etiology of headache, dizziness, and anxiety – and thus improve treatment for all three – have led to the discovery that there are significant comorbidities between each of these conditions, although the specific causes of the correlations have not been identified. Dizziness and anxiety are commonly comorbid.[10-12] Symptoms of migraine associated with dizziness are common enough to be recognized as a distinctive disorder, vestibular migraine.[13,14] Current theories regarding a mechanism that could cause symptoms of headache, anxiety, and dizziness have not been tested.[15] In addition, current proposals link dizziness and anxiety to mechanisms proposed to cause migraine, but people with non-migraine headache also report high levels of dizziness and anxiety.[16]

Vertical heterophoria (VH) is a form of binocular vision dysfunction (BVD) where the line of sight from one eye is vertically higher than the line of sight from the other eye when fusional vergence is disrupted, such as when using a Maddox Rod or prism.[17,18] VH has been shown to cause symptoms of headache, dizziness, and anxiety, as well as ambulation difficulties, neck pain, nausea and motion sickness.[18-22] Prevalence estimates of VH vary widely and range from 7%-52%, with best estimates at approximately 20% of the general population.[23,24] Although VH is common, patients with intractable headache, dizziness, and/or anxiety are rarely screened for VH as there is lack of awareness of this condition within the medical and vision communities.

This study builds on an earlier retrospective study of 38 TBI patients with long-term history of headache, dizziness, and anxiety which had not responded to treatment (average length of symptoms 9.9 years). The earlier study followed the same methods used in the current study and found that application of micro-prismatic lenses to treat the patient's VH led to an average subjective reduction of VH symptoms of 80.2%, as well as a statistically significant reduction in all metrics measuring their headache, dizziness, anxiety and BVD symptom burden.[25]

At least three factors that have prevented identification of VH as a potential cause of headache, dizziness, and anxiety symptoms:

1. Serious symptoms are regularly produced by heterophorias of 2D or below, which are below the levels that can be reliably detected by existing tests for vertical misalignment. In our 2016 study, 68% of participants were treated with vertical prism prescriptions between 0.5–2.00 diopters (mean=1.92D; median=1.5D). Studies measuring the test-retest reliability of current testing methods has measured 95% confidence intervals between 2D and 4D for various techniques.[26,27] Other studies have documented larger inconsistencies both for dissociated phoria and associated phoria tests.[22,28-30] Additionally, there is no consensus on how to interpret the amount of prism to prescribe based on test results. It is common practice to use anywhere from one third the amount to the full amount of prism indicated by the tests.[17,31] As would be expected, our recent study found that dissociated phoria tests did not consistently detect the small vertical misalignments of the participants. The success of tests ranged from 16.2% (Von Graefe phoria – near) to approximately 64% (for both Von Graefe phoria – far and vertical vergence testing).[25]
2. Most vertical heterophoria symptoms are not obviously visual in nature and therefore many patients are not screened for binocular vision dysfunction.[18,25] Patients who present with symptoms of headache, dizziness, and anxiety normally seek treatment from medical doctors who are not aware that these symptoms can be caused by vertical heterophoria and diagnose other conditions.
3. Screening instruments for VH generally examine only a subset of symptoms. For example, the Convergence Insufficiency Symptom Survey (CISS), a commonly used validated survey instrument, queries challenges with reading, headache, asthenopia, difficulty concentrating and visual fatigue. However, it does not query the other symptoms associated with VH such as problems with distance vision, dizziness, lightheadedness, nausea, motion sickness, neck pain, head tilt, anxiety, depth perception, or closing/covering an eye to make visual tasks

easier.[32,33] As a result, patients who do not exhibit the best-known symptoms of BVD will not be screened or diagnosed. Consistent with this expectation, most patients in the cohort examined in our recent study did not report a history of vision issues that would normally be indications of possible heterophoria: diplopia, shadowed/overlapping vision and closing/covering one eye to ease visual tasks was reported by only 39.5%, 34.2% and 34.2% of the patients respectively.[25]

Many highly symptomatic patients have heterophorias under 2.0 D, regularly as low as 0.5 D. Since existing screening and diagnostic tests are not precise enough to reliably identify heterophorias of these small magnitudes, a significant number of patients who have VH symptoms are not detected by these tests. Therefore, the authors developed a method that identifies small amounts of VH in symptomatic patients. This method, known as Prism Challenge, is based upon the standard optometric practice of determining prescriptions for corrective lenses by introducing incremental changes until the patient reports maximum visual clarity. The tester incrementally adds small units of prism (as low as 0.25D) to the subjective refraction until the patient reports maximum visual clarity and minimal symptoms. The patients are asked throughout the process to rate visual acuity and comfort while viewing a visual target. Patients then wear the trial frame for 15-20 minutes and are then again assessed for improvement. The diagnosis of BVD is established when patients report a marked reduction or elimination of BVD symptoms immediately after the application of prism. Although existing phoria tests were not always able to detect VH, we administered one or more tests to every patient to meet the current standard of care, comply with requests of referrers, and to collect data on the relative effectiveness of multiple methods. The primary evidence for the validity of Prism Challenge is the immediate reduction in symptoms of identified patients when treated for vertical heterophoria with prism.

The purpose of this paper is to examine the effectiveness of micro-prism lenses for reduction of headache, dizziness and anxiety in patients diagnosed with vertical heterophoria (VH).

Methods

This retrospective study was approved by Western IRB and adheres to the tenets of the Declaration of Helsinki. The study group included 111 patients who presented to an optometric binocular vision subspecialist between July 2009 and June 2011 for assessment of symptoms consistent with VH.

The study group was drawn from patients who were referred for assessment by specialists, case managers or self after their symptoms had not responded to other treatments. During the period examined in the study, approximately 1150 patients in total were diagnosed with VH after assessment with Prism Challenge and were given prescriptions for corrective lenses including vertical prism.

All patients were asked to complete all survey instruments before treatment and at the completion of their treatment (generally 8-12 weeks after initial appointment). Most of the patients who received treatment did not complete these instruments. Thus, complete data for this study was available for approximately 135 of the patients who were treated during the study period. One of the survey instruments used was a 10-cm visual analogue scale (VAS) with the question, "Compared to the way I felt before I came to Vision Specialists: If you are feeling better, by what percentage have you improved?" A small number of patients (less than 10) who marked a point below 3 cm on this answer at the completion of treatment were excluded from the study. Fifteen patients were excluded because they did not report symptoms of headache, dizziness, or anxiety with the survey instruments used in this study. This study examines the group of 111 patients who completed all survey instruments and whose initial scores on pre-intervention instruments indicate significant symptoms of headache, dizziness, and/or anxiety.

The examination phase consisted of a complete ocular and refractive exam coupled with a detailed binocular vision examination, which included multiple dissociated phoria tests. Patients were assessed with the Titmus test, Von Graefe phoria testing near and far, vertical vergence test and the Modified Thorington test using the Bernell Lantern positioned at 3 feet for vertical misalignment testing. Most participants (83.7%) were assessed with at least three of the five methods. The presence and direction of a head tilt was noted and documented.

VH diagnosis was established with Prism Challenge. Small units of vertical prism (usually 0.25D) are incrementally added to a trial frame containing the patient's subjective refraction. The direction of correction is assigned based on the results of the earlier VH tests and the patient's head posture/tilt. The patients are asked throughout the process to rate visual acuity and comfort while viewing a visual target. The patient then wears the trial frame with prism in place for 15-20 minutes and is then again assessed for improvement. Prism Challenge is considered positive (and the initial vertical prism prescription is established) when the patient reports that the accumulated vertical prism prescription increased visual clarity while simultaneously minimizing BVD symptoms.

The treatment phase entailed the patient wearing the initial refractive and prism prescription (as determined by Prism Challenge) for 2-4 weeks. After this time, the patient returned for one or two follow-up appointments for prescriptive adjustments to address their remaining symptoms. The final follow-up visit took place on average 8-12 weeks after the initial intervention. Final data for this study was collected at that appointment.

Data collected prior to intervention included baseline demographics and a detailed review of systems (ROS). Data collected prior to and at the conclusion of prism intervention included a patient self-assessment of dizziness, anxiety and headache on a 0-10 scale, and results from three validated survey instruments: Headache Disability Inventory (HDI), Dizziness Handicap Inventory (DHI), and Zung Self-Rating Anxiety Scale (SAS). All three tools measure the impact of a condition on a patient's ability to function rather than an abstract measurement of symptoms.

The Headache Disability Inventory contains 25 items which can be answered "no/sometimes/yes", with scores of 0, 2, and 4 for answers that indicate increasingly severe symptoms, leading to a range between 0 and 100. The test has two components, emotional and functional. It has high reliability (Cronbach's alpha analysis r = 0.94). When comparing HDI scores with self-reported headache frequency and severity, the authors found that mean HDI scores for patients reporting mild headaches were 32.33, moderate headaches 33.72, and severe headaches 60.73. Based on the standard error of 10.06, the authors calculated that the 95% confidence interval of a measurable treatment effect would be shown by a 29-point reduction in HDI score. They acknowledged that this number created a significant "floor effect" since many subjects reporting mild or moderate headache pain scored less than 29 on the inventory.[34] The threshold of 20 was chosen to include a majority of patients with at least mild headache disability.

The Dizziness Handicap Inventory also contains 25 items and uses the same scoring format and range. The test has three components, functional, emotional, and physical. It has high reliability (Cronbach's alpha analysis r = 0.91). When comparing DHI scores with self-reported frequency of dizziness, the authors found that mean DHI scores for patients reporting occasional dizziness was 24.8, frequent dizziness 34.2, and continuous dizziness 49.1. However, the standard deviations of scores in each group ranged from 17.8 to 22.3. There were significant differences between the three groups (t=2.16, P = .03 between occasionally and frequently, t=2.54, P = .01 between frequently and continuously). Based on these results, we categorized patients with a score of 10-39 to have mild or moderate dizziness disability, and patients with a score of 40 or higher as having severe dizziness disability. The standard error of measurement was 6.23, so a 95% confidence interval of a measurable treatment effect requires an 18-point reduction in DHI score.[34]

The Zung Self-Rating Anxiety Scale (SAS) includes 20 questions which can be answered with "None or a little of the time," and "Some of the time," "Good part of the time," "Most or all of the time." These produce scores between 1 and 4 for a total score between 20 and 80. The test was validated by testing with a control group and patients with a variety of diagnoses, including anxiety disorder.[35] Later interpretations of the SAS report that a score of 20-35 indicates normal anxiety; 36-47 indicates moderate anxiety, 48-59 indicates marked to severe anxiety, and 60+ severe anxiety.[36] The SAS has high reliability (Cronbach's alpha analysis r = .81). While a standard error for the SAS has not been published, the accepted range between different levels of symptoms is 12 points, and we used this number as the threshold for a significant reduction in symptoms.

Before and after treatment, data was also collected from a subjective rating (0-10 scale) of headache, dizziness and anxiety severity. Upon conclusion of treatment, subjective assessment of overall reduction of BVD symptom burden was obtained utilizing a 10-cm visual analogue scale (VAS) asking the question, "Compared to the way I felt before I came to Vision Specialists: If you are feeling better, by what percentage have you improved?" The final cumulative prism prescription was recorded.

Statistical Analyses

Initial analyses assessed the distributional properties of the study variables pre- and post-treatment. The distributions of differences scores between pre- and post-treatment were symmetric with a single peak, indicating that the assumption of normality of the mean difference scores was tenable. To assess the efficacy of micro-prism lenses for reduction of headache, dizziness and anxiety changes pre- and post-treatment, matched pairs t-tests were performed. Results reporting mean and standard deviations of pre- and post-treatment scores, 95% confidence intervals of changes in scores pre- to post-treatment and p values for differences are provided. Cohen's d, calculated as the difference in mean pre-and post-treatment divided by the pooled standard deviation, is also provided as an effect size indicator for the treatment effect. Significance was set at $p \leq 0.05$. All analyses were completed using SPSS version 22.

Results

In this study, 25 participants (22.5%) were male and 86 (77.5%) were female. The average age was 39.9 years old, with a range of 6 to 80 years old. Average duration of symptoms was 8.1 years (range 1 month to 58 years). Prior to intervention, corrective eyewear (glasses and/or contact lenses) were worn by 80 (72.1%). Eye surgeries were reported by 15 patients (13.5%), three of whom reported surgeries for strabismus. Brain CT scans had been performed for 54 (48.6%), brain MRI had been performed for 58 (52.3%) and both tests had been performed for 39 (35.1%). Past medical history of headache, dizziness or anxiety was reported by 91.9%. Consultation with an ophthalmologist or optometrist occurred prior to study participation in 54.1% of the cases. Presenting complaint, frequency of consultations with specific types of providers prior to binocular vision assessment and prevalence of confounding diagnoses are listed in Figures 1-3.

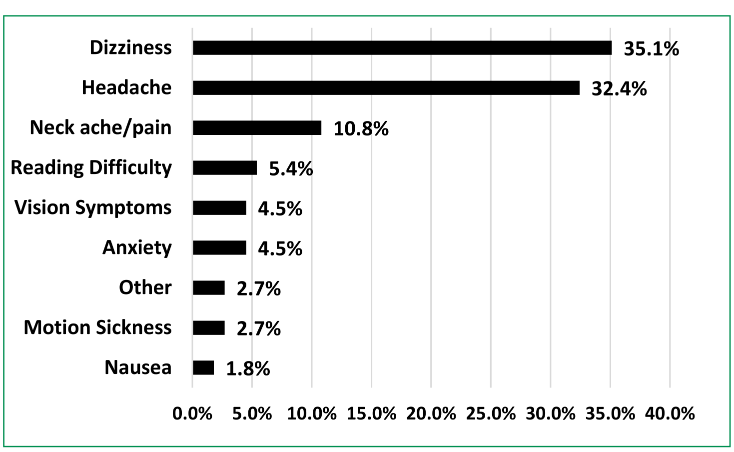

Figure 1. *Presenting Symptom (% of patients)*

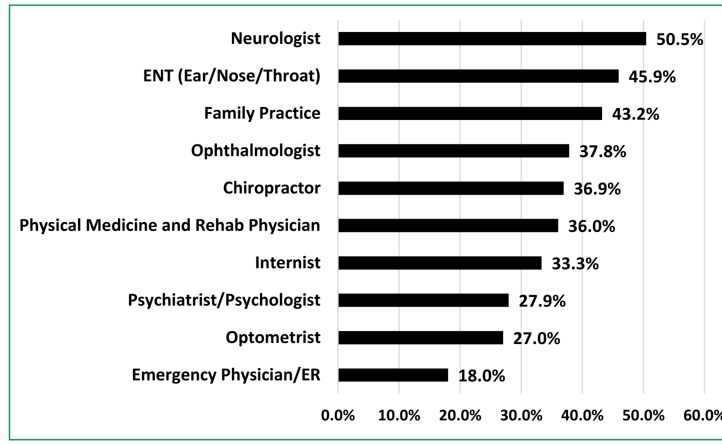

Figure 2. *Specialists Seen Prior To VH Diagnosis (% of patients).*

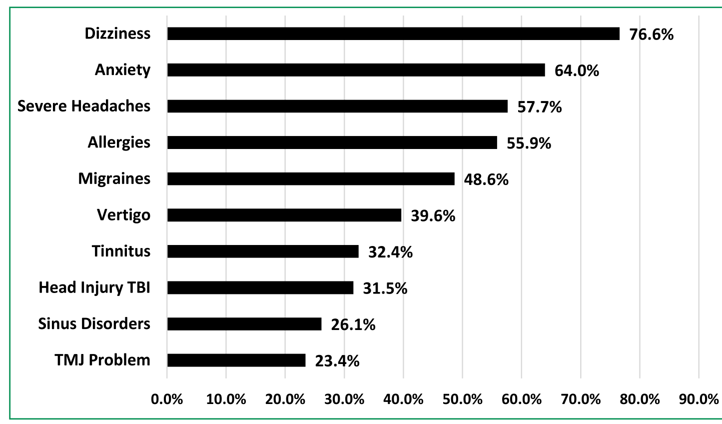

Figure 3. *Most Common Diagnoses Given Prior To VH Diagnosis (% of patients)*

Symptom Prevalence

An extensive ROS was performed and included 84 yes/no questions concerning vestibular symptoms, traditional heterophoria symptoms, reading difficulty, pain, standard vision symptoms, and anxiety symptoms (Table 1). A chart showing the percentage of patients who answered affirmatively to the most pertinent BVD questions in the ROS is included (Figure 4). Headache (78.4%), neck ache (84.7%) and dizziness (76.6%) were reported more frequently than any of the heterophoria or reading symptoms (23.4-72.1%) except for fatigue with reading (76.6%). Diplopia, shadowed/overlapping vision and closing/covering an eye to ease visual tasks were experienced by 23.4%, 30.6% and 24.3% respectively. In the optometric examination, four patients were found to have horizontal heterophoria requiring horizontal prism of 2.0D or greater. Horizontal and vertical prism were both incorporated into the prescription of these patients.

Baseline assessment for headache, dizziness, and anxiety with the HDI, DHI, and SAS showed high prevalence of mild/moderate or severe disability. In total, 85.5% reported mild/moderate or severe disability from dizziness, 66.6% reported mild/moderate or severe disability from headache, and 72.9% reported mild/moderate or severe disability from anxiety (Figure 5). There was considerable overlap between the symptom reports: 46.8% reported symptoms on

Table 1. Symptoms Queried in Review of Systems

Visual Symptoms	Headache/Vestibular/Anxiety Symptoms	Past Medical History
Itchiness	Upper back or shoulder tension	General Fatigue
Spots/Floaters	Neck Ache	Cervical Spine Injury
Dryness	Head tilt	Kidney Disease
Gritty feeling in eyes	Facial pain	High Blood Pressure
Watery eyes	Sinus pain/pressure	Heart Disease
Burning eyes	Headaches	Skin Disorders
Eye strain	Nausea	Asthma
Sore eyes	Dizziness	HIV
Fatigue w reading	Lightheadedness	Thyroid Disorder
Trouble reading	Motion Sickness	TMJ Problem
Difficulty w reading comprehension	Drifting to one side while walking	Head Injury TBI
Losing your place while reading	Unsteadiness w walking	Migraines
Words run together w reading	Ear fullness Right or Left	Severe Headaches
Skipping lines while reading	Feeling uncoordinated	Sinus Disorders
Closing or covering one eye while reading	Vertigo	Meniere's
Trouble learning at work school or other activity	Lightheadedness with close up activities	Tinnitus
Trouble concentrating	Lightheadedness with distance activities	BPPV
Trouble adjusting to prior pair of glasses	Anxiety associated with dizziness	Sleep Apnea
Sudden loss of vision	Feeling overwhelmed or anxious in crowds	ADD ADHD
Flashes of light	Feeling overwhelmed in large spaces	Frequent urination
Tearing	Heart palpitations	Shortness of breath
Redness	Anxiety	Skin Rashes
Blurry near vision	Agoraphobia	Fainting
Trouble working up close		
Blurry distance vision		
Trouble seeing at night		
Double vision		
Shadowed overlapping vision		
Sensitivity to light		
Problems w reflection/glare		
Eye pain		
Pain with movement of eyes		
Poor depth perception		
Lazy Eye		
Cataracts		
Glaucoma		

all three assessments. Mild/moderate or severe anxiety alone was reported by 2.7%, anxiety with dizziness was reported by 18.0% and anxiety with headache was reported by 5.4% (Figure 6).

Pre Treatment Metrics

Most patients were given one or more standard tests for vertical heterophoria. Standard tests do identify larger heterophorias and were judged to be diagnostically helpful in some cases. In other instances, these tests were given at the request of referrers. Because the majority of participants had heterophorias of 2.0D or below, standard vertical alignment tests were not consistently able to identify the heterophorias in this population. Tests given predicted the presence and direction of the misalignment between 25.7%-57.6% of the time, while the observed direction of the head tilt predicted the presence and direction of the misalignment 74.3% of the time (Figure 7).

Pre and Post Treatment Metrics

The survey instruments all showed significant effects from treatment. The validated survey instruments indicated standard effect sizes of d = .54 for headache, d = .72 for dizziness, and d = .80 for anxiety following treatment ($p < 0.001$ for all three). Pre- and post-treatment measurements on these scales indicate significant reductions in the mean score for each group. For headache, the mean score on the HDI

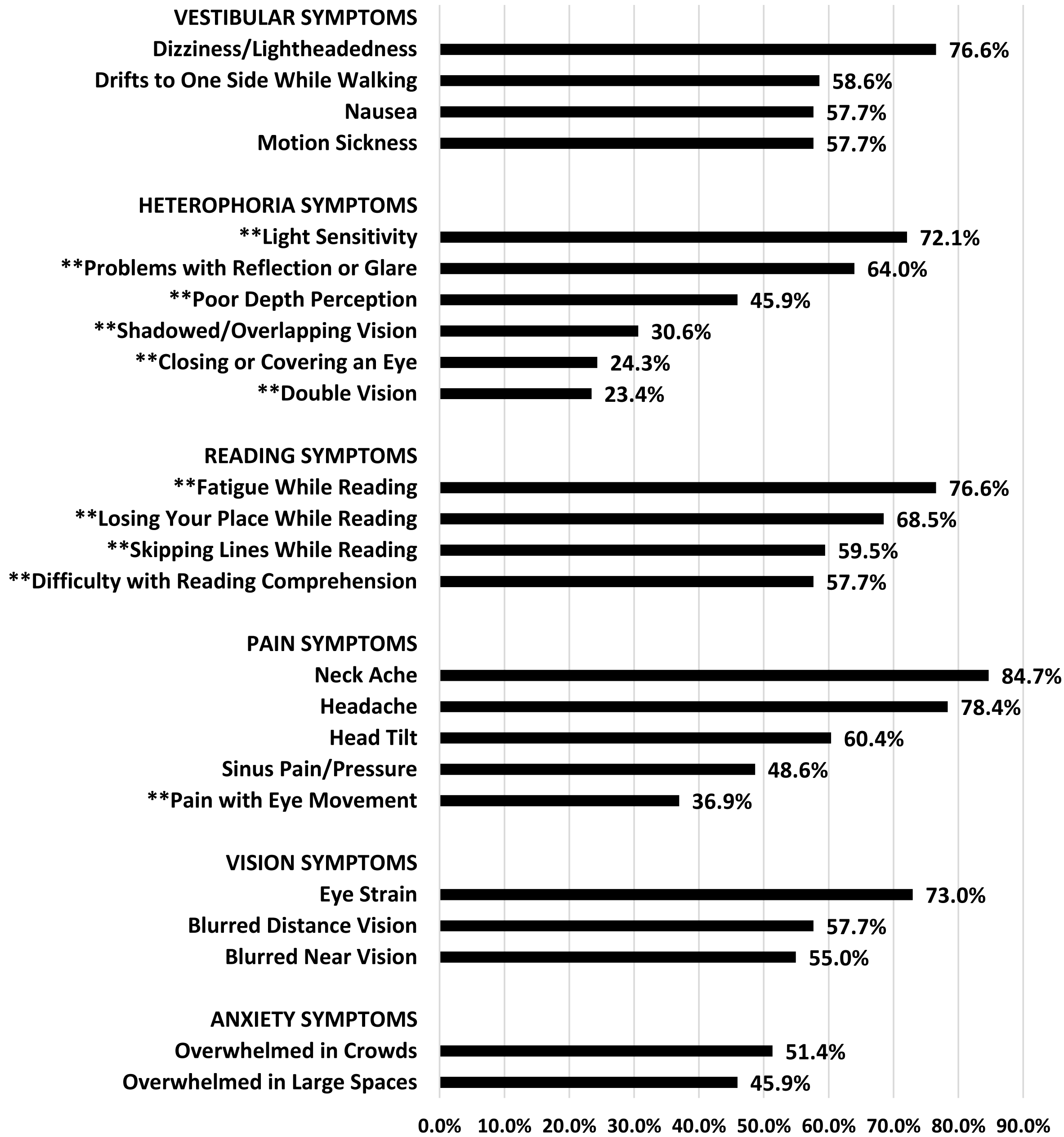

Figure 4. *Prevalence of Vertical Heterophoria Symptoms (% of patients) in 111 Patients (**indicates traditional vertical heterophoria symptoms)*

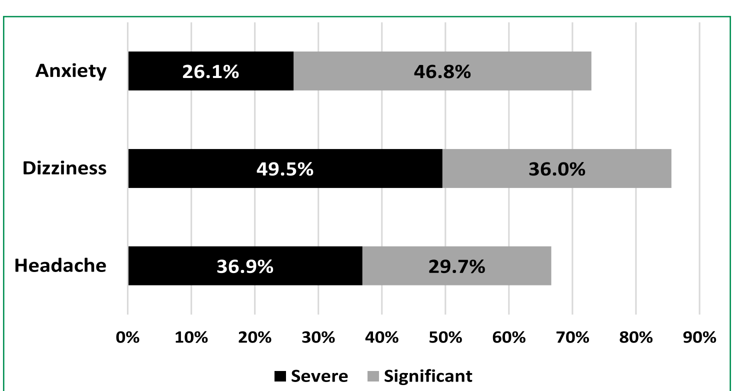

Figure 5. *Patients Reporting Severe or Significant Symptoms*

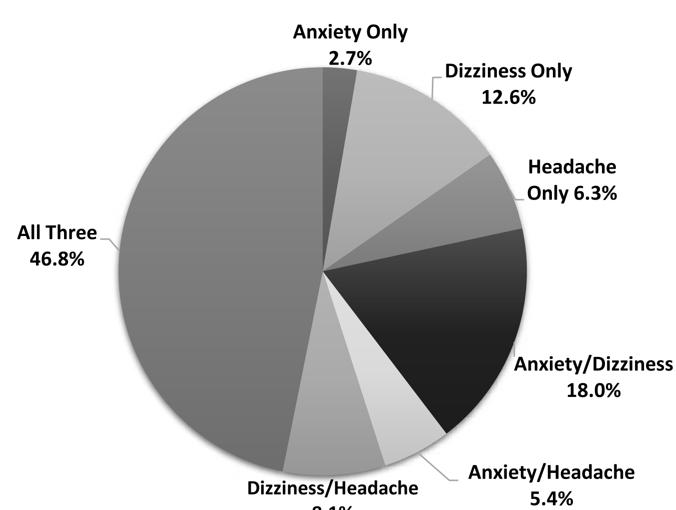

Figure 6. *Symptoms Reported by Patients on One or More of SAS, HDI, and DHI. (SAS≥36, HDI≥20, DHI≥10)*

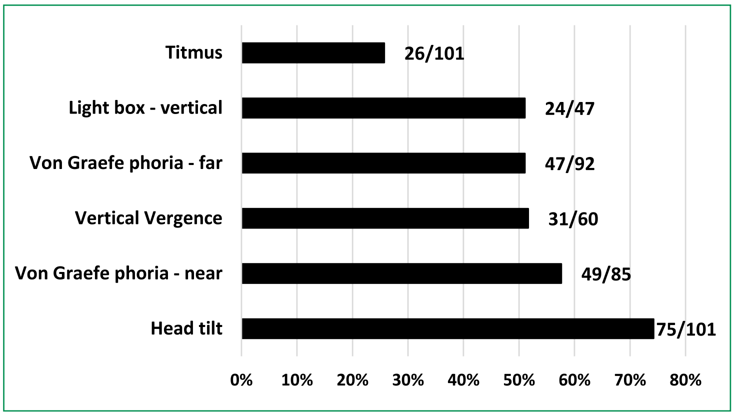

Figure 7. *Vertical Alignment Testing During Initial Evaluation (# correct tests / # of patients tested)*

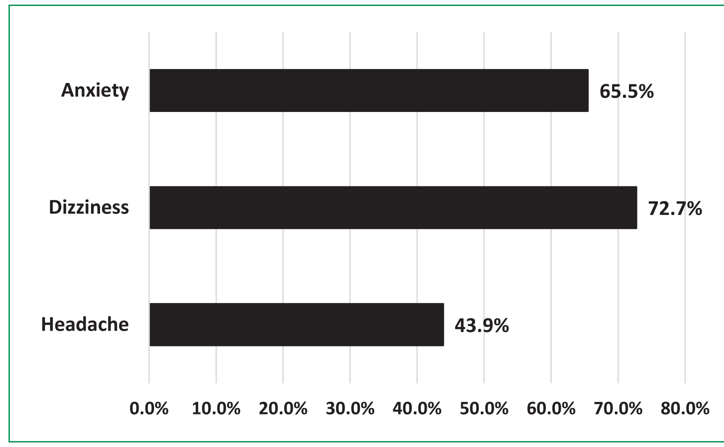

Figure 8. *Percentage of Severely Symptomatic Patients Reporting Improvement*

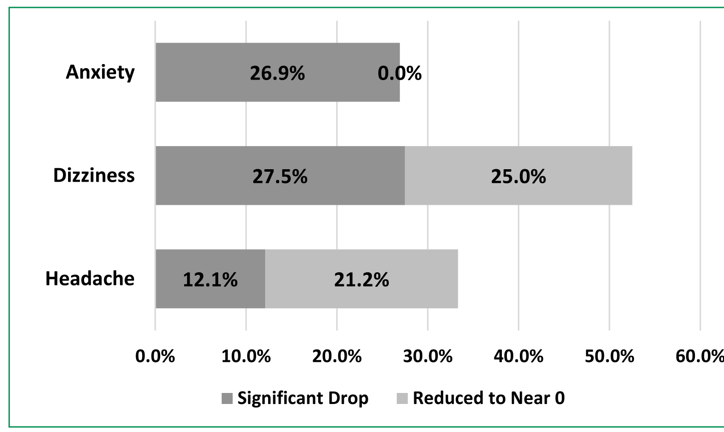

Figure 9. *Percentage of Significantly Symptomatic Patients Reporting Significant Improvement*

was reduced from 37.55 (95% CI:31.80—43.30) to 22.13 (95% CI: 17.24—27.02). For dizziness, the mean score on the DHI was reduced from 38.01 (95% CI: 32.99—43.05) to 18.68 (95% CI: 14.65—22.71). For anxiety, the mean score on the Zung SAS was reduced from 42.13 (95% CI: 40.12—44.16) to 34.22 (95% CI: 32.52—35.92).

The 1-10 rating scale produced effect sizes of d = 1.04 for headache, d = 1.03 for dizziness, and d = .72 for anxiety ($p < 0.001$ for all three). When asked to report their symptom improvement on a VAS, the average mark of improvement was 7.77 cm on the 10-cm line (95% CI=7.51-8.03).

Subgroup analysis of the DHI, HDI and SAS also demonstrated significant improvement. For dizziness, 40 of 55 (72.7%) patients initially reporting severe disability (> 40) due to dizziness had statistically significant reductions of 18 or greater in their post-treatment DHI score. For the 40 patients reporting mild or moderate disability (10-39), 11 reported reductions of 18 or greater on the DHI score. An additional 10 reported initial scores of less than 18 and final scores of 4 or less. Combining these groups, 21 of 40 (52.3%) of mildly or moderately disabled patients reported significant improvement or near-total elimination of symptoms. For headache, 18 of 41 (43.9%) patients initially reporting severe disability (> 45) due to headache had statistically significant reductions of 29 or greater in their post-treatment HDI score. For the 33 patients reporting mild or moderate disability (20-44), 4 reported reductions of 29 or greater on the HDI. An additional 7 reported initial scores of less than 30 and final scores of 10 or less. Thus, 11 of 33 (33.3%) of moderately disabled patients reported significant improvement or near-total elimination of headache disability. For anxiety, 19 of 29 (65.5%) patients initially reporting severe anxiety (>48) had significant reductions of 12 or greater in their post-treatment SAS score. For the 52 patients reporting mild or moderate anxiety (36-47), significant reductions of 12 or greater in their post-treatment score occurred in 14 (26.9%). These results are shown in Figures 8 and 9.

Post Treatment Metrics

Total vertical prism prescription between 0.50 and 2.00 diopters was noted for 75.7% of the participants, between 2.25 and 4.00 diopters for 22.5%, and greater than 4.00 diopters for 1.8% (two participants). Base in horizontal prism prescription of 0.50 was prescribed for 67.6% of participants, 1.0 diopters for 9.0%, 1.5-2.0 diopters for 4.5%, 2.5-4.0 diopters for 3.6%, and 5.0 or greater for 1.8%. Base out horizontal prism was included for 3.6% of patients. Initial measurements of symptoms on the HDI, DHI, and SAS did not correlate with the amount of vertical prism prescribed. The average duration of treatment was 10.7 weeks (range 2.0-48.3 weeks).

Discussion

Identification of VH (a form of BVD) in this patient cohort and treatment of the misalignment with micro-prism lenses led to a marked reduction in all metrics for symptoms of headache, dizziness and anxiety, as well as for subjective metrics for overall symptom reduction.

The average 10.7-week duration of treatment is consistent with our overall clinical experience of 8-12 weeks. During this time, the clinician typically makes 1-3 changes in the lens prescription based on patient reports of changes to their symptoms. While improvements continue to take place over a period of weeks, patients experience almost immediate improvement: every patient considered in this study reported improvements within 20 minutes of the introduction of a corrective lens with vertical prism.

This study demonstrates the ability of the Prism Challenge technique to diagnose and initiate treatment of VH/BVD in patients with headache, dizziness, and anxiety, and to make changes to the treatment to improve outcome. Utilizing this approach, over 10,000 patients with BVD have been diagnosed, treated, and observed over the last 23 years. This has clarified the set of BVD symptoms, many of which are not usually associated with BVD. This approach holds great promise not just for identifying and treating patients but also for further studying BVD and BVD-associated symptoms.

Symptoms traditionally associated with BVD--diplopia, shadowed/overlapping vision and closing/covering an eye to ease visual tasks - were individually experienced by only approximately 25% of this cohort (Figure 4). While 54.1% of the patients had been evaluated by an ophthalmologist, optometrist or both, none had been previously diagnosed with VH. These patients may not be getting diagnosed because they do not report traditional visual symptoms of BVD and are thus not tested, and also because the phoria tests lack adequate sensitivity to reliably identify the presence and direction of vertical misalignment in this patient cohort.[26,27,28,29] Prism Challenge is based on the same principle generally used to determine prescriptions for corrective lenses: patients are given lenses with incremental changes, and a prescription is elucidated based upon the patient's report of minimized symptoms. This has been a much more reliable method of identifying the prism needed to treat the vertical heterophoria and reduce the associated symptoms. It should be noted that the presence of and direction of a head tilt observed during physical examination was the most reliable indicator of the presence and direction of vertical misalignment (Figure 7).

The patients in this cohort had either a very small amount or small amount of vertical misalignment (75.7% having accumulative vertical prism prescription between 0.5 and 2.0D, and 22.5% between 2.5 and 4.0D) yet were quite symptomatic (baseline average HDI=37.5; DHI=38.0; Zung=42.1) and improved significantly with micro-prism lenses. This emphasizes the need to be able to identify and treat heterophorias requiring very small amounts of prism, as they can precipitate significant morbidity.[30]

Males comprised a minority of this patient cohort at 22.5%, which was reflective of the overall population of patients who were assessed during this period. This gender imbalance in symptom reports might be explained by the fact that the most prevalent presenting complaints in this group were dizziness (35.1%) and headache (32.4%) (Figure 1), which are much more common in females than males.

It has been previously hypothesized that, given the coexistence of headaches, dizziness and anxiety symptoms in many patients, there should exist a common cause, with a single common treatment.[15] To the author's knowledge, BVD, of which VH is a subset, appears to be the only entity identified that is causative of all three symptoms, and where treatment positively impacts all three symptoms.

Since evaluating for VH is non-invasive, patients experiencing headache, dizziness, and/or anxiety should be assessed for VH, ideally before prescribing medication or recommending invasive treatments for these symptoms. In particular, patients with a combination of these symptoms, and those who have not responded to other treatments warrant an evaluation for VH.

Study Limitations

This is a retrospective study, and as such, has the potential to introduce certain biases into the data and into the interpretation of that data. The most serious potential bias is the use of patient improvement as a diagnostic tool. While this bias was inherent in the selection, the number of patients excluded on this basis (less than 10) is not high enough to invalidate the study results.

Given that this line of inquiry is new, we are currently the only center reporting data on this at this time. However, we have begun the process of training other vision care providers in our techniques, and it is anticipated that multi-center trials will be performed in the future.

Patients eligible for this study were diagnosed with a report of positive response to prism lenses within 20 minutes of application. It is standard practice in optometry to determine a diagnosis and prescription for corrective lenses by making incremental changes to the prescription until the patient reports minimal symptoms of visual distortion. Ideally the accuracy of Prism Challenge would be verified by comparison to other phoria tests. However, the most precise phoria tests in common use have error of 2.0D. A more precise phoria test would greatly simplify the process of identifying and treating this patient cohort.

The SAS, DHI, and HDI have different scales, and comparative results may reflect differences between the tests. In particular, the lower number of patients reporting statistically significant improvement in headache symptoms may be the result of a high standard error reported on the HDI. We are working on the creation of a validated instrument that will enable a more accurate comparative assessment of symptoms in these and other symptom areas of VH.

Not every patient had every vertical alignment test performed during the initial evaluation, as it was at the discretion of the optometrist as to which test or tests to utilize. While this inconsistent testing strategy could have introduced bias, the large number of patients that were tested with each of the individual tests and the concomitant results (all demonstrating less than adequate sensitivity) makes that less likely.

Only dissociated phoria tests were performed with this patient population, as our previous experience with associated phoria tests found them lacking. An additional study that compared Prism Challenge with both dissociated and associated phoria tests for identifying vertical misalignment would provide a more thorough understanding of the utility (or lack thereof) of these tests in this population.

Since there was no sham control and since patients were not blinded to their treatment with prismatic lenses, it is possible that a placebo effect had an impact on the results. However, this is less likely since the effects of prismatic lenses are not subtle. When prismatic lenses are worn by those who require them, noticeable relief of symptoms is obtained. Conversely, when these lenses are worn by those who do not require them, symptoms of VH develop, most notably nausea, anxiety/dysphoria, and dizziness.

The societal prevalence of VH using this new approach could not be determined from this retrospective study. Additional studies will be required to obtain this important datum.

Conclusions

Treatment with micro-prism lenses (the amount and direction determined by using the Prism Challenge technique) markedly reduces symptoms of headache, dizziness, and anxiety in patients diagnosed with vertical heterophoria. The effectiveness of this treatment approach highlights the need for further prospective and multi-center studies as well as the need for deeper mechanistic understanding of the pathophysiology of VH. The need for further study notwithstanding, the minimal risks and cost effectiveness of this therapeutic approach should make screening for and treating VH a consideration for patients with headache, dizziness, and anxiety. This would be particularly true for those patients who have experienced less than desirable outcomes with standard treatment modalities.

Acknowledgements

James Janisse assisted in statistical analysis. Alan Terlep edited and provided additional statistical analysis.

Dr. Debby Feinberg and Dr. Mark Rosner have a proprietary interest in Vision Specialists of Michigan.

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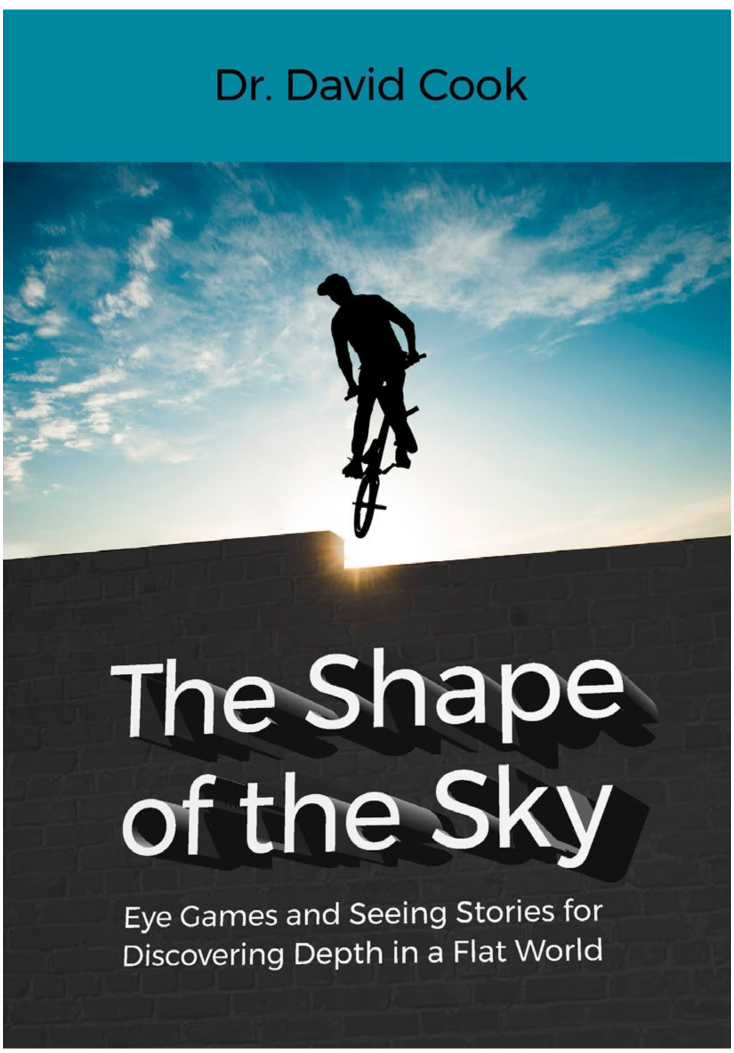

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Our first new book of 2020!
Join author **David Cook**, who for forty years has taught patients to experience the dimensions of space. Dr. Cook's lectures have delighted audiences around the globe. Now he shares his expertise with doctors, therapists, and anyone who has a curiosity about how we see the world.

Vision is not something that happens to us, Cook explains, but rather something we have learned to do. We see what we value. Routine eye exams value how little we can see; this book values how big we can see, the heights of perception rather than just the bottom of the eye chart.

We imagine that those standing beside us share our view of the world. Learn how nothing could be further from the truth. How we do vision is the difference between excelling in the flat, close world of books or navigating the depths of winding, crowded roads in the dark of night.

Having read this book, doctor and patient alike will see the world in a new way, a way that truly captures the shape of the sky.

Watch the interview!

Marion Kraskin

Linda Sanet

I first met Marion Kraskin in 1975, when Bob was a Resident and I was enrolled in the Optometric Technician program at OCNY/SUNY.

Bob was attending the Skeffington meeting in Washington, DC, and as a non-OD, I was allowed to sit in the back of the room as a silent observer.

Bob and Marion had invited us to stay at their home, and honestly I was quite nervous. But they were most kind and generous hosts and I felt comfortable soon after arriving.

Marion was a vision therapist extraordinaire, and I hoped that some day I could be like her. She was very supportive and encouraged me to finish my coursework and get my credential This was at a time when many considered vision therapists to be an "extra pair of hands" in the VT room.

Marion was the epitome of Southern Hospitality. She was also quite a firecracker, who would not take guff from anyone.

Margaret Ronis

I was fortunate to spend 3 summers as a teen working in the office of Dr Kraskin, working with him and Marion. I learned so much from both of them. I learned about behavioral optometry and vision therapy. I also learned how to relate to others. Marion taught me to not be afraid to stand up for my convictions and not to be afraid to speak my mind. She was a role model of a strong, kind, intelligent woman to look up to. She was a wonderful hostess. And she always wanted to hear about my family and scolded me if I didn't keep in touch. I will miss her, especially when coming to the annual KISS meeting.

Steve Gallop

The Kraskins for many years hosted SUNY residents for what they called "Live-a-week of Optometry" on the tail end of what was then known as the Skeffington Invitational Symposium on Vision hosted by Bob Kraskin (now hosted by Jeffrey, as the Kraskin Invitational Skeffington Symposium on Vision or KISS in loving tribute to Bob after his untimely passing). I was not a SUNY resident, but was incredibly fortunate to be invited by Bob and Marion to take part in the Live-a-week program with two other recent PCO graduates around 1991, as the official program was winding down. It was an amazing week of optometry, family and unparalleled hospitality. Watching Bob, Marion and Jeffrey at work every day was indescribable. They were like a three-headed optometrist/therapist guiding a stream of patients through a dazzling array of vision training procedures. From that time on, I felt that Marion was my optometric mom. It was always a special moment for me when I would first sight Marion each year at Skeff/KISS and greet her. Though mostly behind the scenes, Marion was a force in the optometric community, and she surely knew her stuff. I will miss her dearly and I suspect my annual pilgrimage to KISS will be a bit less joyful for some time, as I come to grips with another great loss in my optometric family.

Paul Harris

We lost an amazing woman recently who touched many in the profession of optometry and specifically in those practicing from the behavioral model. She was a strong woman, who could and did hold her own with anyone who engaged with her. She also was a loving woman who would take time and give advice to those in need, and you knew when she gave it, that it was from the heart and was well considered.

She worked side-by-side with the late great Robert A. Kraskin and with their son Jeffrey Kraskin in the office, that was part of their homes as well. The dividing line between home and office was always fuzzy, with them opening up their home to many over the years. Come to an IBO (Institute for Behavioral Optometry) study group meeting a little early and you found yourself upstairs in their living room engrossed in dialogue. The Kraskin's knew how to share and share they did with everything they had.

Marion answered the phones in the office and when I called to chat with Bob or Jeffrey, she and I usually talked for 15-20 minutes at least before I was transferred. She knew how everyone in the profession was, and she knew who needed help and would coopt that help with ease during those phone chats. She knew the politics of optometry inside and out and though she feigned disinterest at times, she would take the bull by the horns when she felt it necessary.

She always spoke her mind plainly and openly, so it was easy to know where you stood with her. She often asked very penetrating questions, some you wondered why you hadn't yet asked yourself the very same question. She was loyal to many and most of all to her husband, to Jeffrey, her family and behavioral optometry.

Marion was an integral part of the Kraskin Invitational Skeffington Symposium on Vision (KISS), for all the years it met. No meeting was complete without an extended chat with Marion. She forged lasting relationships with many including Lucy Johnson. It was a real treat go on a tour of the Johnson Library in Austin, Texas, given by Lucy herself the year that COVD met in Austin. There was Marion by Lucy's side, walking all of us through the closed museum as we got our private tour. You could tell that the bond they had was so strong and so respectful.

We will miss you Marion, but the lessons you taught many of us, including me, will help keep your spirit alive and well in all of our lives. Thank you for taking the time with all those you did. We are better for it.

Nat Flax, OD

Leonard J. Press

Nat was an amazing individual. I first met him at the Skeffington Symposium in D.C. while a Resident at PCO in 1978. Although some of the more seasoned practitioners took issue with my terminology, Nat stood out along with Harold Haynes as maintaining a strong middle ground, bridging the gap between so-called classical and behavioral practice. I was struck by his open-mindedness, and ultimately decided that I would accept the challenge of serving as Chief of the Vision Therapy Service at SUNY. It was in that capacity that I got to see the many facets of Nat. We worked on a monograph together that SUNY published related to VT and Insurance, and he confided that he was having difficulty writing. Puzzled, I asked him why, and he explained that before he could write he had to know the audience that he was addressing, and it wasn't clear to him who the intended audience would be for the monograph. A gifted writer as well as a deep thinker, Nat surprised me one day when he ruminated in his office aloud: "I don't think that people in the profession really know who I am". I hope that by the time he was laid to rest, Nat realized what a profound influence he was on our field. While short in stature, he was one of the giants on whose shoulders we stand.

Daniel Lack

I was sad to learn that Nat Flax passed away. He was one of several teachers at SUNY State College of Optometry who inspired me to practice developmental optometry after graduation. I recall hearing that he had been taught by Daniel Wolff, who had been taught by A.M. Skeffington.

Dr. Flax spoke to my class about his VT-only practice on Long Island and I followed his example by establishing such a practice in upstate New York ten years later. The first of Dr. Flax's many writings that I read in school was an article that had appeared in the Journal of the American Optometric Association a few years earlier in 1972 entitled, The Eye and Learning Disabilities. This was a rebuttal to a position paper, disparaging vision therapy and visual disabilities associated with learning difficulty, that had been published by the medical community. Dr. Flax's paper simply reviewed all of the references of that position paper and revealed that they were unrelated to the medical position or that they actually supported the optometric viewpoint. I followed Dr. Flax's template in my 2010 rebuttal of a subsequent medical position paper, again using their references against them. This is something that I would not have considered if Dr. Flax had not been a mentor.

I was a better optometrist for having known Nat Flax and I extend my condolences to his family.

Linda Sanet

I first met Dr. Flax when I was in a clinical rotation at OCNY/SUNY. I had gotten permission to observe the students and their OD supervisors in the VT clinic.

Dr. Flax saw me, and approached with a brown paper bag in his hands. He asked me if I was patriotic. I was so shocked that he would even notice me that I froze and couldn't say anything.

He handed me the paper bag and said, "I need to know the prescriptions of these glasses." I looked inside – there were 7 pairs. I had learned lensometry and was quite good at it (this was in the days before automated lensometers), but at that moment all of my confidence went down the tubes. The glasses belonged to a patient who had never been happy with any of his glasses, but I didn't know that at the time. Of course the prescriptions were all quite different, and I was so sure that I must be doing something wrong. I handed my form to Dr. Flax, certain that he would think I was incompetent. He smiled and said, "Just as I suspected." A few years later at dinner I told the story to Dr. Flax and Doris. Of course he didn't remember, but we had a good laugh. Because he was a colleague of Bob's, I was fortunate to get to know him and Doris. He was a thoughtful, warm, and caring man who had a wicked sense of humor.

Paul Harris

Optometry recently lost a philosopher, a clinician, a writer, and a teacher, the late Nathan Flax. I had the good fortune of having him as a teacher while at SUNY in my formative years. He taught case analysis and it was from him that I first heard of the Skeffington Analytical Sequence, commonly known as the 21-point analysis. I learned check, chaining, and typing and how to calculate the gross net and the net net. More importantly, I learned how the findings related to each other and how the patterns in those findings were the critical thing, not any one finding.

He also taught other methods of analysis but it was clear and evident which one he backed when push came to shove. He was a leader in insurance reimbursement for vision therapy by optometrists and he helped to bring us a more critical and scientific evidence-base for what it is we do.

His style of speaking was high-speed with lots of content per unit time. If you fell behind, it was nearly difficult to catch up with him. His brilliance was evident all the time and you learned to never stop paying attention in class as you might get called on to answer a question.

Nat left behind a legacy in writings, and audio recordings but also, he agreed to be interviewed by Greg Kitchener for the Heritage series. I had the good fortune to run one of the camera's and hear the interview in person: https://www.oepf.org/remote-video/oep-foundation-heritage-series-interview-dr-nathan-nat-flax

Nat will be missed greatly. The profession was greatly enhanced because of his many contributions.

Rick Morris

We lost a great one when Nat passed away. You wont be able to print this one but I would like to share it with you.

A family came into my office in Florida and said they wanted to continue therapy. They were from New Jersey so I asked who they were seeing. They said "Dr. Flax … he's kind of tough". Ok. Fast forward about a year and I see Nat at a COVD meeting. I walk up to him and ask if he remembers this family. Off hand, he says he doesnt. I remind him that the family said he was a little tough. That is when he told me this: "You need to get the best acuity you can on the first visit. So I look at the parent and say that I may be a little rough with you child, turn to the child and say "OK now cut the crap, read the bottom line!!!" He told me that he he has never failed to get standard acuity before treating a child with a non-malingering syndrome.

Article • Spectral Transmission of Sunglasses from Patients with Various Inherited Retinal Diseases

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Illinois College of Optometry, 2018

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ABSTRACT

Background: Light comprised of ultraviolet and blue wavelengths is known to cause potential damage to the retina after chronic exposure. Those with already compromised retinas are potentially at a greater risk of experiencing damage from this light exposure. Subsequently, it is likely important that such patients wear the most optimal sun protection to try and diminish this potential risk. As such, we sought to determine the effectiveness of their sunglass lenses for filtering blue and ultraviolet wavelengths of light in a group of patients with compromised retinas.

Methods: Forty subjects with various inherited retinal diseases were included in the study. We inquired by a simplified questionnaire how patients selected their most recent sunglasses and how satisfied they were for reducing their discomfort from light exposure. The light transmission quality of their selected lenses was measured with a spectral transmission lensometer.

Results: The average percentage of blue light transmitted from subjects' measured lenses was 13.9% (range 0-60%) and that most (70.0%) subjects' lenses blocked all UVB and UVA light. Most (82.5%) subjects were either very satisfied or satisfied with the protection of their current sunglasses from discomfort during light exposure. Their sunglasses were mainly selected due to a recommendation by an eye care professional (35.0%) or by fashion (30.0%).

Conclusion: Most subjects were satisfied with the comfort afforded by their sunglasses although, on the whole, they did not provide ideal protective qualities in reference to filtering blue light. Eye care providers and fashion made the most contributions towards sunglass selection.

Keywords: blue light exposure, inherited retinal diseases, retinal toxicity, sun protection

Introduction

Photons of light are absorbed by photoreceptors within the human retina resulting in retinal phototransduction and facilitation of the retinoid cycle. When the rod and cone photoreceptors absorb light, they are potentially subjected to damage depending on the characteristics of the exposing light. These characteristics include: wavelength, intensity, and duration of exposure.[1,2]

Ultraviolet (UV) light has been defined as light within the 100-400 nanometer spectrum[1] and blue light has been defined as light within the 400-500 nanometer spectrum.[3] Studies show that light comprised of these wavelengths can cause retinal damage.[3,4] Thus, it is important that people with already compromised retinas, such as patients with inherited retinal diseases, be protected from these potentially most harmful wavelengths. Studies conducted on mouse models mimicking autosomal dominant retinitis pigmentosa showed exposure to white light accelerated the progression of the condition.[5,6] Similarly, studies conducted on mouse models mimicking Leber congenital amaurosis demonstrated acceleration of disease progression following exposure to white light comprised of 350-700 nanometers.[7] Further studies conducted on rats with retinitis pigmentosa and those with albinism have led scientists to recommend elimination of blue light transmission in sunglasses.[3,8,9] It has been determined that if all wavelengths of light under 500 nm are completely filtered, then the risk of phototoxicity to the retina is reduced by 98%.[10] Hence, an optimally protective lens would be one in which all UV and blue light wavelengths were filtered.

Sunglasses have a role in providing comfort and likely some degree of ocular protection from potentially harmful wavelengths of light. However, their potential protective quality can vary greatly between brands. Transmission of UV light has been found to vary from 1.5% to 40% in sunglasses.[11] Further, it is probably less likely that a majority of people consciously select sunglasses based upon their perceived light transmission quality, or reducing the threat of retinal damage, but rather on other factors such as their appearance, comfort, or cost. In this study, we sought to understand how patients with various inherited retinal diseases were selecting their sunglasses and the potential protective quality of their sunglasses, particularly for the filtering of ultraviolet and blue light.

Methods

Subject Selection

Forty patients seen at the Pangere Center for inherited retinal diseases in Chicago, IL were randomly selected. All scheduled patients were requested to bring their sunglasses to their upcoming appointment. Patients without inherited retinal diseases were excluded. Further, patients who were unable to evaluate the satisfaction of their sunglasses due to recent purchase and minimal wear-time were excluded (N=2). Patients with more than one pair of sunglasses were asked to supply the pair that they wear most frequently (N=9). Subject demographics are summarized in Table 1.

Procedure

This study was approved by the Western Institutional Review Board and was in accordance with HIPAA regulations as well as the tenets of the Declaration of Helsinki. Subjects who agreed to participate were informed of the nature of the study as well as any risks or benefits of participating. All subjects signed a consent form. A simplified, multiple-choice questionnaire (Table 2) was administered. The sunglass transmission properties were measured using a Humphrey Lens Analyzer 360 Auto Lensometer (ZEISS, New York, USA). The lensometer measured percent transmission of UVB, UVA, and visible light. Percent transmission of blue light was determined by taking the peak transmission spectrum between 400-475nm. This range was selected because the blue spectrum begins at 400nm[5] and it has been found that photoreceptors may be damaged by wavelengths of 475nm or less.[12] To determine if the spectral transmission differed between sunglasses provided by subjects who selected their sunglasses on the basis of a recommendation by an eye care provider or those who selected on the basis of fashion or cost, a two-sample t-test assuming equal variances was performed. To determine if the spectral transmission differed between sunglasses provided by subjects who were dissatisfied or unsure if they were satisfied with their current sunglasses for protecting their eyes against discomfort during light exposure verse satisfied subjects, a two-sample t-test

Table 1. Summary of subject demographics and various retinal diseases

Sex	
Males	17 (42.5%)
Female	23 (57.5%)
Age (years)	
Mean	46.2
Range	18-78
Ethnicity	
Caucasian	29 (72.5%)
Hispanic	6 (15%)
African American	5 (12.5%)
Condition	
Retinitis Pigmentosa	14 (35%)
Stargardt Disease	14 (35%)
Cone-Rod Dystrophy	6 (15%)
Cone Dystrophy	2 (5%)
Late-Onset Retinal Dystrophy	1 (2.5%)
Familial Drusen	1 (2.5%)
Myopic Degeneration	1 (2.5%)
X-Linked Retinoschisis	1 (2.5%)

Table 2. List of questionnaire inquiries

1. How satisfied with your current sunglasses are you for protecting your eyes against light exposure? a. Very satisfied b. Satisfied c. Unsure d. Dissatisfied
2. On what basis did you select your current pair of sunglasses? a. Fashion b. Cost c. Recommendation by eye care professional d. Other (please list)
3. How long have you worn your current pair of sunglasses? a. A few days b. A few weeks c. A few months d. A year or more
4. Are the sunglasses you provided today the only pair you wear when a sunglass is necessary? a. Yes b. No c. Unsure

assuming equal variances was performed. Statistical significance was determined by having a p-value less than 0.05. Subjects were informed of the results and counseled on optimal sunglass selection.

Results

Questionnaire

Most subjects (82.5%) felt that they were very satisfied or satisfied with the effectiveness of their current sunglasses for facilitating less light discomfort. The reasons subjects selected their sunglasses were as follows: recommendation by an eye care professional (35.0%), fashion (30.0%), cost (17.5%), or comfort (17.5%). A majority of subjects (62.5%) had worn their sunglasses for a year or more. Most subjects (77.5%) provided sunglasses that were the only pair they wore when a sunglass was needed.

Spectral Analysis

Transmission data are summarized in Table 3. Seventy percent of subjects selected lenses that blocked all UVB and UVA wavelengths. The average percent of blue light transmitted was 13.9% with a range of 0%-60.0% and a median value equal to 12.0%. The average percent of visible light transmitted was 16.5% with a range of 1.0%-66.0% and a median value equal to 14.0%. Table 4 shows that there was no statistical difference in the spectral transmission of UVB, UVA, or violet light between sunglasses provided by subjects who selected their sunglasses on the basis of cost/fashion or recommendation by an eye care provider (all p-values greater that 0.05). There was a statistical difference in the transmission of blue light (p-value=0.03). Sunglasses provided by subjects that selected them due to a recommendation by an eye care provider had a statistically lower percent transmission of blue light than subjects who selected their sunglasses on the basis of fashion/cost. Table 5 shows that there was no statistical difference between the spectral transmission of UVB, UVA, blue or ultraviolet light from sunglasses worn by subjects who were dissatisfied or unsure if they were satisfied with their current sunglasses for protecting their eyes against discomfort during light exposure versus satisfied subjects (all p-values greater than 0.05).

Table 3. Percent spectral transmission data of measured lenses

UVB	
Mean	0.18
Range	0-1
Median	0
UVA	
Mean	0.45
Range	0-11
Median	0
Blue Light	
Mean	13.9
Range	0-60
Median	12.0
Visible Light	
Mean	16.5
Range	1-66
Median	14.0

Table 4. The statistical difference between the spectral transmission data of sunglasses provided by subjects who selected their sunglasses on the basis of a recommendation by an eye care provider versus fashion/cost.

Spectral Transmission Range	P-value
UVB	0.96
UVA	0.21
Blue	0.03
Visible	0.09

Table 5. The statistical difference between spectral transmission data from sunglasses being worn by subjects who were dissatisfied or unsure if they were satisfied with their current sunglasses for protecting their eye against discomfort during light exposure versus satisfied subjects.

Spectral Transmission Range	P-value
UVB	0.81
UVA	0.62
Blue	0.43
Visible	0.92

Discussion

Retinal damage as the result of blue light exposure has been considered as controversial. While some have questioned whether blue light can damage the retina, the weight of the evidence regarding potential harm warrants a recommendation to reduce exposure of UV and short-wavelength light. There are studies conducted on rhesus monkeys that determined cone photoreceptors were damaged by exposure to blue light of 463 nm.[13,14] It has been determined that rhesus monkeys serve as a model for similar human tolerance in regard to retinal light toxicity.[15,16] Another concern is that nearly 90% of blue light is transmitted through the cornea, lens, and vitreous humor.[17] As such, the photoreceptors are exposed to much of the offending light. In patients with certain inherited retinal diseases, their photoreceptors are already degenerating. The RPE is damaged by blue light and the already impaired photoreceptors may be subjected to even further damage from the compromised RPE function that is necessary for the survival of photoreceptor cells.[18]

Our questionnaire results showed that most sunglasses were selected due to either a recommendation by an eye care professional or fashion. A potential selection bias might occur if an individual visual practitioner recommended a specific sunglass tint as traditionally occurs with one of the authors (GAF), who recommends brown-tinted sunglass lenses that are known to poorly transmit blue light.[19] Additionally, the questionnaire results showed 77.5% of subjects had only one pair of sunglasses that they wore regularly. Further, most lenses were worn for a year or more, and subjects were overall satisfied with the comfort that their sunglasses provided from light exposure. Question 1 of our survey asked subjects to rate their satisfaction with their lenses for protection against light exposure. This question was intended to ascertain the protection from light discomfort during exposure to light. It does not address protection from retinal tissue damage that could be independent from the level of discomfort.

The spectral transmission results showed that most subjects were wearing sunglasses that filtered UV light and transmitted, on average, 16.5% of visible light (up to 66%) and 13.9% of blue light (up to 60%). Statistical analysis showed that recommendations by eye care providers resulted in subjects selecting sunglasses that filtered out more blue light than those who selected sunglasses on the basis of fashion/cost. There was not a statistical difference in the spectral transmission of sunglasses from subjects that were satisfied or dissatisfied with their sunglasses for protecting their eyes against light exposure.

Our study underpins the observation that in our cohort of patients, the participants, unknowingly, were selecting sunglasses that were not comprehensively filtering blue light. This finding suggests that visual practitioners should practice due diligence when advising patients as to the selection of their sunglasses.

It is of relevance to note that various factors other than the spectral transmission of sunglasses could impact upon light exposure to the retina, such as, the frame design of the sunglasses, presence of a nuclear sclerotic cataract, and whether or not a brimmed hat was worn.

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Clinical Highlight • VT Procedure: Marsden Ball Games

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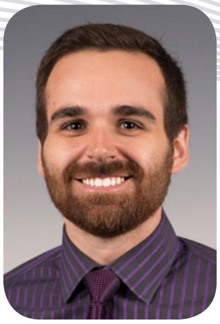

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Michigan College of Optometry, Pediatric Optometry, 2017

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University of Regina, Biology, 2009-2012

One vision therapy tool that I find to be both versatile and fun is the Marsden ball. This consists of a baseball-sized ball attached to a string that is suspended from the ceiling. The ball can have letters and numbers drawn it and some versions have red-green components to address suppression issues.

To begin, the therapist should gently swing the ball towards the patient. The patient should follow the ball with their eyes through the entire procedure, and should use the palm of one hand to gently hit the ball back to the therapist. At this basic level, the activity encourages strengthening pursuit movements, and also helps to reinforce coordination between the eyes and the hands. Additionally, all forms of this activity aid your patient in improving visual-spatial abilities. For the cherry on top, a solid core rubber ball with a length of string attached to it can be inexpensively produced, and easily sent home with your patient for use during their home therapy.

As your patient becomes able to track the ball effectively, and consistently returns the ball, the procedure can be varied. Instead of a full hand, your patient can use only their pointer finger to return the ball. This will encourage finer motor coordination, relative to using the entire hand. The patient can alternate hands, or the therapist can call "right" or "left," and the patient must use the correct hand to return the ball. This can aid their understanding of laterality.

To increase the cognitive demand, the patient is asked to call out a letter or number from the ball before they return it to the therapist. Once this becomes easy, the patient is asked to call out a word that begins with a letter that they see. Distractions can also be added to the activity. For example, the therapist can ask questions while the ball games are being performed. By loading the activity, you are helping to make the visual skills associated with these games more automatic. This will make it easier for the patient to transfer these skills into their daily life, and to ultimately function at their desired level.

Marsden ball games are an effective technique to use early on in therapy, both because of the relatively low initial difficulty, and fun for many patients. If your patient is struggling with the most basic level of this activity, there are a couple of modifications that you can make. Reducing the speed and arc of the ball can make it easier for your patient to track and react to the ball. If necessary, simply have your patient track the ball with their eyes, without using their hand to hit the ball back to the therapist. Once they are more confident, and able to track more effectively, the hand portion can be re-introduced.

While this is by no means an exhaustive list of everything you can do with a Marsden ball, I hope that this provides a good introduction to its use. The Marsden ball is an effective tool for helping your patient to understand visual-spatial relationships, as well as for improving tracking abilities and eye-hand coordination.

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- The article can be on any topic related to visual performance
- Can be a Case Report, Review Article, or Article of Discovery (research)
- Must be original, unpublished work
- Minimum length is 1500 words
- The style must follow *Optometry & Visual Performance* guidelines

Who is eligible?

- The applicant must be a full-time student in an optometric program

How does it work?

- Articles must be submitted to the Editor in Chief of *Optometry & Visual Performance*, Marc B. Taub, OD (mtaub@sco.edu) by June 1st.
- The winner will be selected by the *Optometry & Visual Performance* editorial board and announced by June 15th.

Upcoming Events

Sports Vision
3-5 April 2020
LOCATION: OEP-NEC, Timonium, Maryland
SPEAKERS: Paul Harris, OD, the team doctor of the Baltimore Orioles and Geoff Heddle, OD
CONTACT: Karen Ruder at karen.ruder@oepf.org
EVENT INFO: http://bit.ly/39c7HLP

COVD 50th Annual Meeting
21-25 April 2020
LOCATION: Toronto, Canada
EVENT INFO: https://covd2020.org

OEPF Clinical Curriculum: The Art & Science of Optometric Care – A Behavioral Perspective
29 April – 3 May 2020
LOCATION: Melbourne, Australia
SPEAKER: Dr. Paul Graham, B.App.Sc Optom (Hons) FACBO
CONTACT: Karen Ruder at karen.ruder@oepf.org
EVENT INFO: ACBO.org.au

OEPF Clinical Curriculum: The Art & Science of Optometric Care – A Behavioral Perspective
29 April – 3 May 2020
LOCATION: Red Deer, Alberta, Canada
SPEAKER: Virginia Donati, OD
CONTACT: Karen Ruder at karen.ruder@oepf.org
EVENT INFO: http://bit.ly/39fEXSv

VT Foundation 2020: Hands-On Therapy Training Course
2 May – 20 June 2020
LOCATION: Over the Internet Sessions and 3-Day In-Person Training
INSTRUCTORS: Robert Hohendorf, OEP Prof. Emeritus (online); Alma Privette, COVT (in-person training); R. Hohendorf and A. Privette (follow-up)
CONTACT: Karen Ruder at karen.ruder@oepf.org
EVENT INFO: http://bit.ly/38fB7aC

OEPF Clinical Curriculum: VT3/Strabismus & Amblyopia
14-17 May 2020
LOCATION: Halifax, Canada
SPEAKER: John Abbondanza, OD
CONTACT: Karen Ruder at karen.ruder@oepf.org
EVENT INFO: http://bit.ly/32M8YXO

Basic Introduction to Behavioral Vision Care Webinar
18 May 2020
LOCATION: Online
CONTACT: Karen Ruder at karen.ruder@oepf.org
EVENT INFO: http://bit.ly/32D1F4u

Regional Clinical Seminar: Visualization: The Critical Link Between Vision Therapy and Learning
23-24 May 2020
LOCATION: Red Deer, Alberta, Canada
SPEAKER: John Abbondanza, OD
CONTACT: Karen Ruder at karen.ruder@oepf.org
EVENT INFO: http://bit.ly/38ciioL

OEPF Clinical Curriculum – ABI/TBI
29-31 May 2020
LOCATION: Athens, Greece
INSTRUCTOR: Paul Harris, OD
CONTACT: Karen Ruder at karen.ruder@oepf.org

OEPF Clinical Curriculum: VT2/Learning Related Visual Problems
3-7 June 2020
LOCATION: Ft. Lauderdale, Florida
INSTRUCTOR: Robin Lewis, OD
CONTACT: Karen Ruder at karen.ruder@oepf.org
EVENT INFO: http://bit.ly/38eeovM

OEPF Clinical Curriculum: VT1/Visual Dysfunctions
3-7 June 2020
LOCATION: Metro Boston, Massachusetts
INSTRUCTOR: John Abbondanza, OD
CONTACT: Karen Ruder at karen.ruder@oepf.org
EVENT INFO: http://bit.ly/32E0Zff

The ACTION Forum (Workshop)
SAVE THE DATE! 12-14 June 2020
More to follow!
CONTACT: Karen Ruder at karen.ruder@oepf.org

For a complete list of events, please visit the OEP website at: bit.ly/OEPFcalendar