Australian Orthoptic Journal

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Simple convergence training or computer-based therapies?

Orthoptic phone clinic for NLDO and chalazia

Health-related physical fitness and visual impairment

Paediatric laser pointer induced retinopathy

Intraoperative floppy iris syndrome

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Why Do Simple, Inexpensive Convergence Training Exercises Continue to Perform as Well as More Expensive Computer-Based Home Therapies? Uncoupling Your Expectations

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ABSTRACT

Convergence insufficiency is a common disorder of binocular vision affecting older children, teenagers, and adults. Patients with convergence insufficiency report symptoms of reading difficulty, eyestrain or discomfort associated with near activities, blurred vision, and headache. Affected individuals are unable to maintain fusional convergence during near activities. The diagnosis is made based on a remote near point of convergence and decreased positive fusional vergence amplitudes at near fixation. Treatment of convergence insufficiency includes orthoptic exercises designed to build convergence amplitudes, spectacles to address presbyopia, computer orthoptics that simulate the vergence demands addressed by traditional orthoptic exercises, and office and home-based vision therapy.

Researchers have sought to compare the advantages of more costly, contemporary treatments to inexpensive, simple home therapies with widely varying results. No consensus exists as to superiority of one treatment over the next in terms of reduction of symptoms, or improved objective clinical measures, regardless of cost. Simple, orthoptic convergence training exercises for use at home continue to perform well in patients with symptomatic convergence insufficiency. Three cases treated successfully with simple jump vergence exercises that preserve the fundamental neuro-sensory relationship between convergence and accommodation are presented to illustrate how compliance and adequate treatment application of inexpensive home therapies continues to improve objective measurement of convergence amplitudes and near point of convergence, and subjective symptoms. A review of the visual sciences literature reveals how asthenopic symptoms have been shown to develop in healthy volunteers in laboratory conditions after prolonged viewing of simulated 3-dimensional images on a flat-panel computer monitor like those used in popular computer vergence training programs.

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Keywords: Convergence insufficiency, asthenopia, convergence near point, positive fusional convergence amplitudes

INTRODUCTION

Convergence insufficiency (CI) is a common disorder of binocular vision, characterised by inability of the vergence system to maintain prolonged ocular alignment and accurate focus during near activities, particularly with reading.[1,2] Prevalence has been reported to be 5.3% in children 6-18 years old, 6% in children 8-12 years old, 4.2% in children 9-12 years old, and 7.7% in college students.[3-5] In young and aging adults, it may be isolated and idiopathic or associated with concussion or neurologic disease,[6-12] or it can develop in early middle age, when first-time bifocal use can lead to decreased accommodative convergence.[13] The condition is defined by symptoms which include difficulty with near work, blurred near vision, asthenopia, or diplopia, and objective clinical measures of exophoria or exotropia greater at near fixation,[14] recession of the near point of convergence (NPC) and decreased fusional convergence amplitudes, also known as positive fusional vergence (PFV).[1]

Burian defined exotropic patients in whom the near deviation exceeded the distance deviation by 10 prism diopters (PD) as having CI.[15] But what is normal in terms of NPC or PFV amplitudes? In 1983 Shippman and coworkers[16] reported an average NPC breakpoint of 5 cm (range 1 to 15 cm) in a group of 46 adults with normal binocular vision. The type of target for this testing was not reported. Scheiman and colleagues[17] replicated this result two decades later, reporting 5 cm for the NPC break and 7 cm for the NPC recovery measured using standard pushup technique with a Bernell accommodative rule (Bernell Company, Mishawaka, IN, USA) placed just above the nose at the brow between the two eyes. Normal PFVs vary based on age. In 1927 Behrens and coworkers reported average fusional convergence amplitudes in 218 adult males as 14.0 PD base-out for distance

breakpoint, and 38.0 PD base-out breakpoint for near.[18] Twenty years later, Mellick and coworkers[19] identified mean values and standard errors for PFV in 561 healthy volunteers across all age groups and with normal neuromuscular systems, reporting 18.0 ± 0.26 PD base-out for near fixation, and 26.0 ± 0.4 PD base-out for distance fixation. Lower values for PFV were obtained by Saladin[20] in 1978. More recently Razavi and coworkers[21] studied 111 adults with a mean age of 25.6 years, 11.0 ± 4.5 PD base-out for near fixation, and 15.5 ± 6.0PD base-out for distance fixation. Of interest, the investigators found no correlation between the amount of measured exophoria and values of PFV at distance or near.

Treatment for CI is initially non-surgical and of varying expense. These treatments include less expensive orthoptic home therapies which include smooth convergence exercises, often referred to as pencil pushups or pen convergence, jump vergence exercises such as the Brock string and near point dot cards, and computer vergence exercises. Moderately expensive treatments include spectacles with or without base-in prism to correct diplopia and relax the vergence effort, refractive error or presbyopia. Weekly office-based vision therapy programs come at a cost premium.

Advantages and disadvantages of home-based treatment

Advantages to simple home-based therapies like pencil pushups or jump vergence exercises are simplicity, and cost. Contemplating cost, it is important to consider not just direct cost of the treatment sessions, but also indirect costs associated with frequent office visits, missed work, and missed school days. Proper technique is important, such as using a target that stimulates accommodation during pencil pushups. Non-accommodative targets, for example the featureless eraser on a pencil, may fail to stimulate accommodative convergence. Adequate time, 15-30 minutes spent per day doing the exercises and enough repetitions is also important,[22] and will contribute to successful treatment outcomes.[22,23] One important disadvantage to these simple treatments is that they can be uninteresting and fail to engage the user for extended treatment periods, especially a younger patient. Furthermore, home-based therapies which rely on simultaneous perception or diplopia recognition without suppression of the diplopic image from a dissociated exodeviation may fail by design. Stereograms and computer orthoptic programs like the popular CVS (Computerized Vergence System) program (Computer Orthoptics, Gold Canyon, AZ) rely on bifoveal fixation for correct responses and performance of the exercise.[24]

It is interesting to consider the clinical data from treatment studies comparing advantages of these simple home-based therapies to potentially more engaging and technologically driven treatments such as computer orthoptics. These studies typically analyse and compare objective measures such as NPC and PFV, or subjective data obtained from validated symptom survey instruments. Review of the literature has shown that results vary, with no consensus as to superiority of one treatment over the next, regardless of cost. Simple, inexpensive home convergence training exercises, compared to home computer vergence exercises, continue to perform well by these measures, even in comparison to office-based vision therapy.

Scheiman and coworkers[26] compared efficacy of office-based vision therapy (VT), which included treatment with computer orthoptics to pencil pushup testing (PPT), in 46 adults aged 19 to 30 years with symptomatic convergence insufficiency. The investigators concluded that intensive office-based VT was more effective than less intensive PPT for improvement of NPC and PFV amplitudes. Despite a study design flaw that introduced a treatment dosing bias favouring the more rigorous, in-office vision therapy, there was a statistically significant measured decrease in symptoms in both groups. Momeni-Moghaddam and colleagues[27] also compared PPT with weekly, office-based VT in 60 university students. In their study, VT treatments did not include computer orthoptics, including only combinations of traditional orthoptic exercises, including stereograms, a Brock string, prism bars and jump vergence exercises. The investigators found that NPC, amplitude of near phoria, and PFV amplitude results did not statistically differ between the two treatment groups. More recently, the Pediatric Eye Disease Investigator Group (PEDIG) evaluated improvement in symptoms comparing home-based computer orthoptics, with home-based PPT in children aged 9 to less than 18 years with symptomatic convergence insufficiency.[28] The study was underpowered due to insufficient recruitment. Nonetheless, the proportions of enrolled participants reaching a successful outcome, defined by predetermined composite criteria from a convergence insufficiency symptom survey, was the same for both treatment groups at the 12-week outcome visit, 23% or 16 of 69 participants in the home-based computer orthoptics group (95% CI: 14-35%) and 22% or 15 of 69 participants (95% CI: 13-33%) in the PPT group. Curiously, 5 of 31 participants (16%, 95% CI: 5-34%) in a sham computer vergence placebo group were classified as having a successful outcome. Compliance, assessed by unmasked site personnel estimates of the frequency and duration of completed therapy per session from 0 to 6 weeks and 6 to 12 weeks based on electronic data from the computer vergence programs and interviews with the participant and/or a parent at each visit, was found to be 68% for the computer vergence group, 49% for the PPT group, and 52% for the placebo group.

Several recent studies have reported home-based computer vergence training does improve objective findings and reduce symptoms.[29,30] Despite the excellent compliance with computer vergence training reported by the PEDIG trial, compliance can be an issue with computer orthoptics. For example, Cochrane Collaboration published a 2011 review of nonsurgical treatment for convergence insufficiency, reporting compliance with pencil

pushups at 84.9%, and computer orthoptics at 67.3%.[31] These findings raise the research question here, why do simple home vergence therapies like pencil pushup exercises, Brock strings and stereograms, continue to perform comparably in terms of both objective clinical measures and subjective symptom surveys, to sophisticated computer vergence exercises?

The visual sciences literature

In free space viewing conditions, the human brain generates a 3-D picture essentially by having two eyes spaced a short distance apart. Each eye captures a slightly different perspective of what is in front of it. In the eleventh century, Ibn al-Haytham first described a special set of points in free space where single vision occurs.[32] Franciscus Aguilonius coined the term horopter 500 years later to describe the locus of all points lying on a horizontal line passing through the point of fixation that resulted in a single perceived image, while objects in free space slightly in front of or slightly behind this line resulted in double images.[33] Panum further described this area of fixation in the visual space just proximal to what was subsequently referred to as the empirical horopter, where images seen by each eye fall on slightly disparate retinal points, as the narrow area where stereopsis exits,[33] now known by his name. By fusing these two disparate images, the human brain perceives a single image with real depth, or stereopsis, the highest form of binocular vision. Retinal blur and the accommodation required to clear the image varies continuously with changes in scene depth.[34] Vergence distance, driven by disjunctive, binocular eye movements and focal distance to the target, driven by fixation with a monocular change in accommodation, are the same. Under these circumstances, vergence distance and focal distance are coupled (Figure 1).[35] Accommodative changes evoke vergence changes, and vergence changes evoke accommodation changes, which is the near reflex as described by Fincham seven decades ago.[36] Advantages of coupled vergence distance and focal distance are increased speed of accommodation and vergence, as well as reduced fusion times required to discern the cyclopean stimulus in a random-dot stereogram.[35] Coupling enhances human high-grade sensorimotor fusion in all fixation ranges.

Three-dimensional displays work by generating two separate versions of the same depicted image, in several different ways. These include anaglyphic images (one red image and one green or blue image, perceived separately by each eye using glasses, similar to those used with the Worth 4-dot test), polarised images (each perceived separately using polarised glasses, such as those used with the Titmus or Randot stereo tests), and active shutter glasses that work by opening and closing the left and right lenses in an alternating manner and at very high speed.[37] In each method, one image is seen by the left eye, and one by the right eye. To create the proper illusion of real depth, the left eye's image must not be seen by the right eye, nor must the right eye's image be seen by the left eye. Lastly, lenticular displays work without additional special glasses, using a plastic screen overlay that sends slightly different pictures to each eye so that a single fused three-dimensional image is perceived, but only when seated in a specified location in front of the screen. But in viewing a 3-D display, unlike viewing a real object in free space, vergence distance (to the simulated virtual image behind or in front of the screen) is no longer equivalent to focal distance

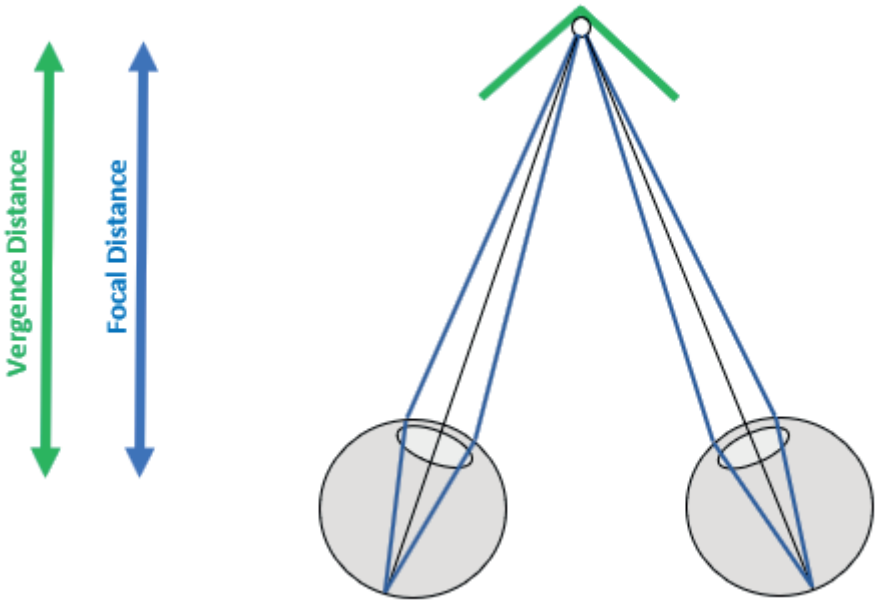

Figure 1. Neural coupling: In real-world viewing, vergence distance (driven by disjunctive, binocular eye movements) and focal distance to the target (driven by fixation with a monocular change in accommodation) are the same (Redrawn by the author, adapted from Hoffman et al.[35]).

to the target (the surface of the screen). Vergence distance and focal distance are then said to be uncoupled (Figure 2).[35]

In 2002, several years after 3-D monitors and televisions became commercially available, researchers began looking into public concern about potential adverse effects associated with extended viewing of screen-generated stereo imagery, with specific reports of increased viewer fatigue and discomfort with prolonged use of computer displays simulating a 3-D viewing experience.[35,38-41] Hoffman and coworkers[35] developed a novel volumetric 3-D display capable of presenting coupled or uncoupled focusing cues to test subjects at only one base viewing distance of 39 cm or 2.5 dioptres in the laboratory. The researchers found that when focusing cues were coupled as in any real-world viewing experience, the time required for healthy volunteers to identify a stereoscopic image was reduced, stereoacuity accuracy in a time-limited task improved, distortions in depth perception were reduced, and test subjects reported less viewer fatigue and discomfort. The authors showed that under laboratory conditions, asthenopia developed due to the uncoupling of vergence and accommodation required with viewing computer-simulated 3D displays.[35] The normal correlation between focal (accommodative) distance and vergence distance were disrupted, with focal distance fixed on one static display surface as vergence distance continued to vary depending on where on the computer or TV screen the subject was looking. In other words, a conflict between vergence demand and accommodation demand per se causes discomfort and fatigue. Shibata and colleagues[42] expanded on this work, developing a 3-D display that could manipulate vergence distance and focal distance independently. They presented masked test subjects with visual tasks at multiple viewing distances in different sessions in order to determine which distances caused the greatest symptoms, evaluated with a 5-point Likert symptom survey tool. In three experiments, the authors examined i) the effect of viewing distance on discomfort and fatigue, ii) the effect of vergence-accommodation conflict on discomfort and fatigue, and iii) the predictive qualities of measured phoria and zone of clear single binocular vision. They found that vergence-accommodation conflicts are a cause of visual discomfort associated with viewing stereo displays. In the first experiment, their data predicted that at a given range of disparities in the displayed image, subjects became more comfortable as they moved farther from the display screen. In the second experiment, data predicted that minifying content and viewing at close distance, for example viewing simulated 3-D content on a smart phone or electronic tablet device, yielded slightly less visual discomfort, while magnifying content and viewing it on the large surface of a cinema screen at a far distance should yield slightly more discomfort, largely due to a subject's inability to diverge his or her eyes comfortably for distance. In the third experiment, measured phoria and fluctuation of vision outside of an established zone of comfort were found to be predictive of development of asthenopia. As subjects attempt to resolve these conflicts, symptoms of eye strain, headache, and visual fatigue were reported. The authors assumed that visual discomfort associated with viewing 3-D displays is caused by motor and not sensory aspects of the vergence. Accommodation conflict was not directly tested and remains a topic for future research.

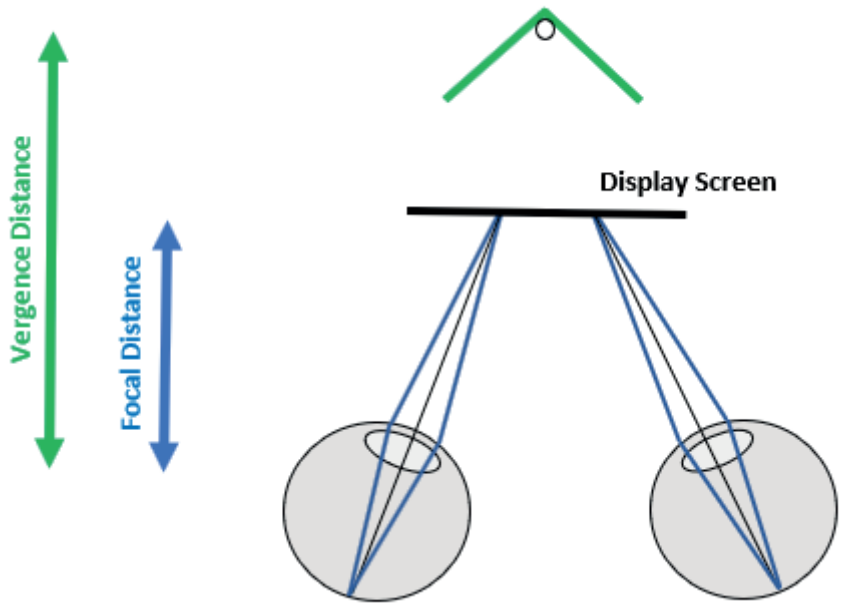

Figure 2. Neural uncoupling: Vergence distance, which varies depending on the distance being simulated by the content on the display screen, is no longer the same as focal distance to the target (the screen surface) (Redrawn by the author, adapted from Hoffman et al.[35]).

CASE REPORTS

Symptoms of patients with CI do not always correlate well with objective measures.[29,43] For the purposes of this report, the reader should assume normal values for positive fusional vergence amplitudes to be breakpoint of 20 PD base-out prism at distance fixation, and breakpoint 40 PD base-out prism at near fixation, approximating an average of the values discussed earlier in this report from Behrens,[18] in 1927 and Mellick[19] in 1929, which reflect the author's clinical practice. Measured values for underlying heterophoria were added to breakpoint and recovery values obtained with the base-out prism bar to obtain the final values for PFV amplitudes reported for each case. NPC was measured using a Royal Air Force (RAF) Rule (Sussex Vision, UK), and the vertical line with a central dot for convergence fixation target (Figure 3). The rule is placed on the cheeks of the face, over the nose. The fixation cube is then advanced along the 50 cm rail of the RAF rule in the primary reading position, from a remote position greater than 20 cm toward the patient until horizontal diplopia of the fine vertical fixation line and central dot is reported. The author has found this vertically oriented target line allows precise and accurate detection of diplopia from the small-angle horizontal strabismus the moment fixation is lost. For patients without CI or any other abnormalities of vergence, normal NPC is assumed to be 2-4 cm, the point on the RAF rule where the 50 cm rule meets the cheek rest (Figure 4). This is closer than previously published normative values described earlier in this report, and admittedly the fixation target will be blurred for most patients, but in the author's experience, normal patients can easily converge to this distance. Distance fixation is fixation on an accommodative target at the end of a 6-metre exam lane. Near fixation is fixation on an accommodative target at 33 cm. Results of the Worth 4-dot are described as i) sensory fusion (4 dots), ii) diplopic response (5 dots simultaneously), or iii) suppression (2 green dots or 3 red dots at either distance or near fixation). Table 1 summarises the relevant clinical data and measurements obtained at the initial orthoptic evaluation for each patient. Table 2 summarises the relevant clinical data, measurements, and treatment compliance obtained at the final orthoptic evaluation. There was no masking of the examiner.

Case 1

A 58 year-old right-handed Caucasian female was referred by her general ophthalmologist for symptoms of reading difficulty. For almost a year, she reported having to close one eye while reading to avoid 'confusing' text images. She denied diplopia. Her past ocular history was significant for early-childhood amblyopia for which she did some patching between the ages of 5 and 10 years, and essential blepharospasm for which she had received Botox injections every 4 to 5 months for over a decade, but no injections in the days or weeks prior to the initial orthoptic examination. She had worn spectacles to address her myopic astigmatism since grade school, and in recent years multifocal spectacles were used to address her presbyopia. Her past medical history was significant for schizophrenia, gastroesophageal reflux disease and migraine without auras, all treated with medication.

Best-corrected Snellen distance visual acuity was 6/6 in each eye and she read Jaeger 1 font at 36 cm in each eye. There was sensory fusion with the Worth 4-dot test at distance and near fixation, and 140 arc-seconds (4/9 circles) of Titmus near stereo

Figure 3. RAF (Royal Air Force) Rule and inset detail of near target block with vertical line and central dot for convergence fixation used by the author to accurately quantify near point of convergence (Modified image from Sussex International, UK, used with permission).

Figure 4. Retouched detail of RAF rule extending the centimetre rule scale toward the cheek guard placed over the patient's nose to demonstrate the 2 cm 'normal' value for NPC used by the author.

(Stereo Optical Company, Chicago, USA). She was orthophoric in all positions of gaze in the distance, with a 6 PD exophoria measured at near. NPC was 2 cm with effort, but PFV testing revealed a breakpoint of 6 PD base-out for distance and 12 PD base-out for near (Table 1). The diagnosis of convergence insufficiency was made based on the reduced PFV amplitude and reported symptoms.

Treatment was initiated with near point dot card simple jump-vergence home exercises, essentially a paper version of the Brock string (Figure 5), the goal being to fuse the most proximal dot on the card, located approximately 2 cm away from her eyes with the end of the card placed at the tip of her nose, while maintaining perception of the desired, V-patterned physiological diplopia of the line of beads regressing away from her nose. The author uses a custom 12-dot version of this card with an upper case letter A labelling the furthest dot from the patient, an upper case letter X labelling the 7th, middle dot on the line approaching the patient, and an upper case V labelling the most proximal dot to the patient, to serve as reminders as to what pattern of physiological diplopia the patient should perceive as they converge correctly and accurately on the labelled points along the line connecting the dots on the card. This activity was to be performed two or three times a day for 10 minutes per session, with a scheduled return visit in 8 weeks to re-evaluate signs and symptoms.

The patient returned 6 weeks later reporting excellent compliance having done the exercises five or six times per day for 10 minutes each session. There was sensory fusion with the Worth 4-dot at distance and near fixation, and 100 arc-seconds (5/9 circles) of Titmus near stereo. She was orthophoric in all positions of gaze in the distance, and this time she was orthophoric at near fixation as well, fixating through the near add segments. NPC was still 2 cm with effort, but PFV testing had increased to breakpoint 18 PD base-out, recovery point 14 PD base-out for distance and no breakpoint with up to 40 PD base-out at near fixation (Table 2). No spectacle prism was required or recommended.

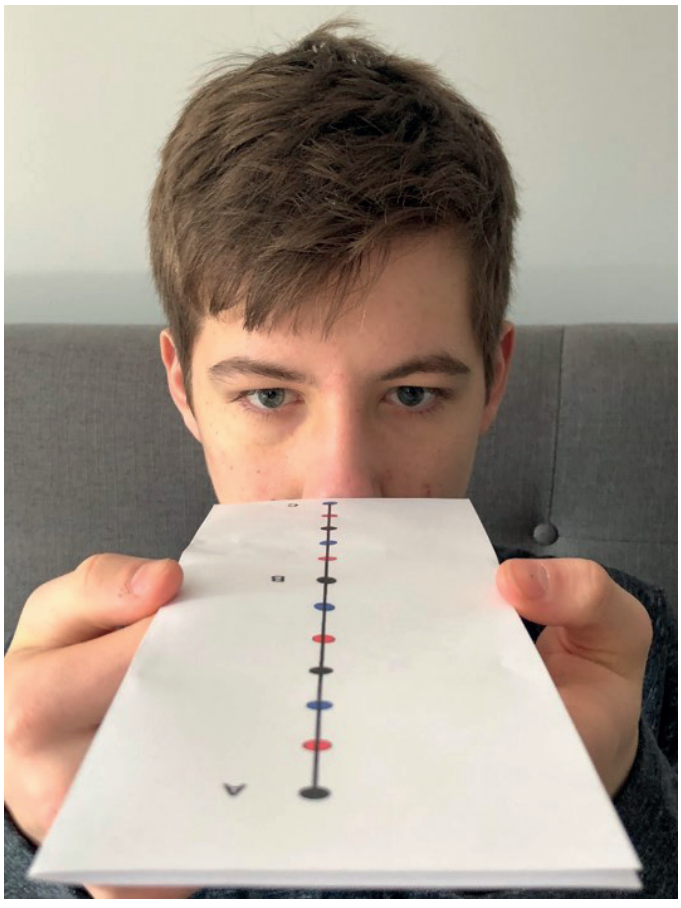

Figure 5. Teen male demonstrating an example of simple home jump convergence exercises with a near point dot card.

Case 2

An emmetropic 11 year-old girl was seen with symptomatic CI. Her symptoms sometimes developed in the mornings on school days, initially consisting of blurred vision followed by a low-grade headache. Her mother denied any maternal family history of migraine headache and there was no reported diplopia. There were no other reported neurological signs or symptoms.

Uncorrected Snellen visual acuity was 6/6 in each eye. Near acuity was not recorded. There was sensory fusion of the Worth 4-dot at distance and near fixation, and 25 arc-seconds of Titmus near stereo acuity. She was orthophoric in all positions of gaze in the distance, with a 2 PD exophoria measured at near. NPC was 6 cm with effort. PFV testing revealed a breakpoint of 6 PD base-out at distance fixation and 12 PD base-out at near fixation. Recovery points for both fixation ranges were not recorded (Table 1). The diagnosis of convergence insufficiency was made based on the reduced PFV amplitudes, slightly remote NPC and reported symptoms.

The treatment plan was to start with the near point dot card jump-vergence exercise described above, three 10-minute sessions per day, with the short-term goal being to appreciate the desired physiological diplopia responses described in Case 1, with the card held at the end of her nose.

The patient returned 10 months later for re-evaluation for recurrent symptoms associated with near activities, which developed after having stopped the orthoptic exercises because she lost the card. Compliance with the prescribed paper Brock string exercises was good initially after the first exam and her headache symptoms disappeared completely.

On return evaluation there was sensory fusion of the Worth 4-dot at distance and near fixation, with 40 arc-seconds (9/9 circles) of Titmus near stereo. She remained orthophoric at distance fixation and there was 2 PD of exophoria measured at near fixation. NPC had improved to 4 cm, and most impressively PFV had improved to 16 PD base-out breakpoint, 10 PD base-out recovery point at distance fixation and 25 PD base-out breakpoint, 10 PD base-out recovery point at near fixation. In summary, this patient experienced a reduction of symptoms, a two-fold improvement in PFV amplitudes at both distance at near and a 50% improvement in measured NPC since she began doing the simple jump-vergence home therapies, even after having discontinued the treatment for a number of weeks prior to re-evaluation (Table 2).

Case 3

A 71 year-old adult female was evaluated for an 8-month history of symptomatic strabismus and vertigo following a brainstem stroke causing a left hemiparesis. Her chief complaint was asthenopia with diplopia at near fixation, with a suspicion for convergence insufficiency trending toward spontaneous improvement over time up until a few months before the initial orthoptic examination. She had been doing smooth vergence pencil pushups to improve tracking, recommended by her neurologist. The patient denied a childhood history of strabismus or amblyopia.

Best-corrected Snellen linear visual acuity was 6/6 in the right eye and 6/15 in the left, improved to 6/6 with manifest refraction. Near acuity was Jaeger 4 on the right at 33 cm, improved to Jaeger 1 at the same test distance with manifest refraction, and Jaeger 1 on the left at 33 cm. There was central sensory fusion of the Worth 4-dot at near fixation, a diplopic response at distance fixation, and 40 arc-seconds (9/9 circles) of Titmus near stereo. She was orthophoric in all positions of gaze at distance fixation, but there was an intermittent exotropia (IXT) of 10 PD at near. NPC was very remote at 18 cm. PFV testing revealed a breakpoint of 16 PD base-out, recovery point 14 PD base-out at distance fixation, and breakpoint of 20 PD base-out, recovery point 15 PD base-out at near fixation. Diagnosis was symptomatic CI, with remote NPC and decreased fusional

Table 1. Initial orthoptic examination data

Case	Sex	Age (years)	NPC	Proximal fusion vergence Break/recovery	Near stereo	Motility at distance	Motility at near	Treatment prescribed	Acuity RE	Acuity LE
1	F	58	2 cm	6Δ base-out (F) 12Δ base-out (N)	140 arc-secs 4/9 circles	Orthophoria	X 6Δ	Near point dot card	6/6	6/6
2	F	11	6 cm	6Δ base-out (F) 12Δ base-out (N)	25 arc-secs 9/9 circles	Orthophoria	X 2Δ	Near point dot card	6/6	6/6
3	F	71	18 cm	16/14Δ base-out (F) 20/14Δ base-out (N)	40 arc-secs 9/9 circles	Orthophoria	X(T) 10Δ	Near point dot card	6/6	6/15

convergence amplitudes at distance and near (Table 1), but in the context of anisometropic refractive error, -1.25 dioptre spherical equivalent in the left eye. With best-corrected near acuity in trial frames, the near diplopia all but resolved, she could read at a normal range, so the recommendation was to update the spectacle correction and return for orthoptic re-evaluation.

The patient returned 6 weeks later, still complaining of diplopia associated with reading despite the updated spectacles. Best-corrected Snellen linear visual acuity was 6/6 in both eyes. Near acuity Jaeger 1 at 33 cm in both eyes. Once again there was central sensory fusion of the Worth 4-dot at near fixation, but a vertical diplopia response at distance fixation. Titmus near stereo had decreased to 80 arc-seconds (6/9 circles). There was a 2 PD symptomatic but non-localising right hypertropia, comitant in all gaze positions at distance fixation, and an 8 PD symptomatic exophoria at near fixation. NPC had improved to 8 cm. PFV was not tested in lieu of addressing the symptomatic vertical tropia first. Accordingly, her spectacle correction was updated to include 2 PD base-down prism in the left lens, which resolved her diplopia in free space in the clinic, and the patient was asked to return with the updated glasses for re-evaluation of the CI.

She returned five months later, her vertical diplopia having resolved with the vertical prism spectacles. But she was still symptomatic at near fixation, with headache, some of which was now being called post-stroke chronic headache by her neurologist, asthenopia and intermittent diplopia causing her to lose her place while reading. Best-corrected Snellen linear visual acuity was 6/7.5 in the right eye and 6/6 in the left eye. Near acuity was Jaeger 1 at 33 cm in both eyes. There was central sensory fusion of the Worth 4-dot at both distance and near fixation, and 60 arc-seconds (7/9 circles) of Titmus near stereo. NPC was still 8 cm and PFV amplitudes were reduced (breakpoint of 14 PD base-out, recovery point 12 PD base-out at distance fixation, and breakpoint of 18 PD base-out, recovery point 16 PD base-out at near fixation). Diagnosis was now symptomatic CI, with remote NPC and reduced PFV amplitudes, remaining symptomatic over time despite good acuity at distance and near in both eyes, and vertical prism in the distance glasses that was working well, with no reported vertical diplopia. Treatment was to add home jump-convergence exercises, again the near point dot card to be used two to three times every day for 10 minutes each time and to return in 6-8 weeks to repeat the sensorimotor exam.

Five months later she returned having compliantly performed the home convergence exercises with the near point dot card for at least 10 minutes per day, 6 days per week. Her headaches persisted, and this was being treated with medication by her neurologist. Subjectively, she reported improvement in her reading symptoms, not losing her place as much as before she started the convergence exercises. Best-corrected Snellen linear visual acuity was 6/7.5 in the right eye and 6/6 in the left. There was central sensory fusion of the Worth 4-dot test at distance and near fixation. Titmus near stereo was 60 arc-seconds (7/9 circles). She was orthophoric in all positions of gaze in the distance, with a 10 PD exophoria near fixation. NPC showed improvement to 6 cm. PFV had improved, with breakpoint of 25 PD base-out, recovery point 20 PD base-out at distance fixation, and breakpoint of 35 PD base-out, recovery point 25 PD base-out prism at near fixation (Table 2).

DISCUSSION

Cases 2 and 3 met the entry criteria for near point of convergence (>6 cm), but all three met entry criteria for positive fusional vergence at near (<15 PD base-out) used by the CITT investigator group[25] and Serna et al[26] in their evaluations of children with symptomatic CI. All three patients improved in both reported symptoms and objective clinical measures of NPC, and PFV amplitudes, using simple, inexpensive jump-vergence exercises, and did not require the addition of more

Table 2. Final orthoptic examination data

Case	Sex	Age (years)	NPC	Proximal fusion vergence Break/recovery	Near stereo	Motility at distance	Motility at near	Treatment compliance	Treatment duration	Acuity RE	Acuity LE
1	F	58	2 cm	18/14Δ base-out (F) >40Δ base-out (N)	100 arc-secs 5/9 circles	Orthophoria	X' 2Δ	50 minutes daily for 6 weeks	6 weeks	6/6	6/6
2	F	11	4 cm	16/10Δ base-out (F) 25/10Δ base-out (N)	40 arc-secs 9/9 circles	Orthophoria	X' 2Δ	20 minutes daily for 9 of 10 months	10 months	6/4.8	6/4.8
3	F	72	6 cm	25/20Δ base-out (F) 35/25Δ base-out (N)	60 arc-secs 7/9 circles	Orthotropia	X' 10Δ	10 minutes daily	11 months	6/7.5	6/6

expensive treatments such as computer vergence training, or formal vision therapy. The goal for treatment dosing was 20-30 minutes of the jump-vergence training per day, 6 days per week using the near point dot card (Table 2). Jump-vergence near point dot card exercises were performed compliantly in two of the three cases, yet all three eventually reported improvement in symptoms.

These patients might have shown short-term improvement by using a concentrated program of base-out computer vergence exercises designed only to improve their convergence, as reported by Huston.[30] However in that study, data regarding reported improvement of either subjective symptoms, objective clinical measures, or both were obtained after only 6 weeks of treatment and then at some 'later' time, not specified by the authors. To this author's knowledge, no long-term data exist from any treatment comparison study reporting compliance, improvement in objective clinical measures, or reported adverse events of computer-based vergence training exercises. For example, in the CITT from 2005, comparing office-based vison therapy to smooth vergence pencil push-up treatment, the outcomes visit was at 12 weeks. This study was also biased by a design flaw comparing vigorous weekly office-based vision therapy to far less vigorous PPT of just a few minutes per day, pointed out in an editorial by Kushner, who felt that this amount of PPT did not reflect the practice pattern and level of therapy recommended by the orthoptists with whom he worked, and of those whom he surveyed.[22] In the Momeni-Moghaddam trial from Iran in 2015,[27] another direct comparison of office-based vision therapy utilising computer orthoptics to smooth vergence pencil pushup treatment, outcomes visits were at 4 weeks and 6 weeks after initiation of treatment. Finally, in the PEDIG trial from 2016, a direct comparison of computer vergence training to smooth vergence pencil pushup treatment, the outcomes visit was completed at 12 weeks. One could argue that these time periods are insufficient time to draw long-term conclusions about the efficacy of any treatment for CI. The timeline of these shortened outcome visits may have masked asthenopic symptoms that could have developed with longer periods of computer-based treatment. Prolonged uncoupling of vergence from accommodation by using screen-based therapy for extended periods has been shown earlier to induce symptoms in healthy volunteers, possibly making it less effective than in office-based or home therapies. Could this then have explained why there was better compliance with PPT than with computer orthoptics reported by Scheiman in the 2011 Cochrane review discussed earlier in this report?[31]

Two of the cases described in this report were followed for extended periods, from 5 months (Case 3) to almost a year (Case 2). Both patients demonstrated improvement in objective measures and reported symptoms. The author's personal clinical experience echoes that expressed by Kushner, who reported resolution of symptoms and clinical improvement in positive fusional vergence and NPC in 16 consecutive patients treated over an unspecified period of time with home jump vergence or smooth vergence exercises prescribed by the certified orthoptists with whom he worked.[22]

As previously discussed, evidence exists in the visual sciences literature that describes how the process of neural coupling occurs in human free-space viewing situations to ensure that the accommodative demand required to provide clear vision in both eyes at any given focal distance is synchronised with the vergence demand required to provide a single image in clear focus at the specified viewing distance. The data are clear that asthenopia develops in healthy volunteers when neural uncoupling of vergence from accommodation occurs as test subjects in a controlled laboratory environment attempt to maintain fixation on static, simulated 3-D display monitor like those used routinely in computer orthoptic treatment of symptomatic convergence insufficiency. For patients with convergence insufficiency, the static screen necessary to generate and display the simulated 3-D images used in popular computer orthoptics exercises could derail initial improvement of symptoms by inadvertently uncoupling vergence from accommodation.

CONCLUSION

An uncoupling occurs between vergence and accommodation while maintaining fixation on static, simulated 3-D displays like those used in 3-D cinema projection, 3-D gaming on tablets and smart phones, and on display screens used in popular computer vergence training programs, producing symptoms in healthy volunteers. Controlled studies comparing computer vergence training to jump and/or smooth vergence orthoptic exercises for symptomatic convergence insufficiency should be carried out for extended periods of time greater than the one to three months precedent in the current CI literature to further explore the potential consequences of inadvertently uncoupling vergence from accommodation in the treatment of symptomatic convergence insufficiency. Simple smooth or jump convergence orthoptic exercises remain an inexpensive, safe, readily obtainable, and clinically effective way to treat these patients. Orthoptic exercises that utilise real targets preserve the coupled relationship of vergence to accommodation that occurs normally as individuals attempt to maintain clear, single binocular vision in free space, and in particular, with near activities.

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Retrospective Review on the Orthoptic Phone Call Clinic for Nasolacrimal Duct Obstructions and Chalazia

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ABSTRACT

Ophthalmology departments in public health systems worldwide are overburdened with high referral numbers and long wait times. This has necessitated the development of new models of care to improve patient access and maximise clinic efficiency. Nasolacrimal duct obstructions (NLDO) and chalazia are two common paediatric conditions that have a high chance of resolution with conservative management alone. The Queensland Children's Hospital developed a phone call clinic to manage these referrals to better triage and prioritise children and encourage initiation of conservative management prior to outpatient presentation. This paper describes the clinical processes and protocols in the design of this phone call clinic and a retrospective discussion of its outcomes. Two hundred and seventy appointments were made available within a 16-month timeframe, with no additional staff or resources required. The findings of this review would suggest that orthoptists can be utilised in the triaging process to help with clinic efficiency and patient care.

Keywords: orthoptic-led, clinic efficiency, nasolacrimal duct obstruction, chalazia

INTRODUCTION

Congenital nasolacrimal duct obstruction (NLDO), or more commonly referred to as a blocked tear duct, is a delay in the development of the lacrimal system resulting in a membranous obstruction of the nasolacrimal duct, known as a Hasner membrane. It presents as epiphora and/or mucopurulent discharge which can be either constant or intermittent. Due to the resultant stagnant drainage system, the eye is more prone to bacterial conjunctivitis. Nasolacrimal duct obstruction is a common condition, evident in up to 20% of infants.[1] It is usually unilateral but may be bilateral, and is commonly asymmetric in these instances. NLDO typically spontaneously resolves, with 95% of cases doing so by 12 months of age.[1,2] As a result, it is usually treated conservatively and includes cleansing the eyes and lids and massaging the duct to build pressure within the system and release the Hasner membrane. Massage has been reported to be highly effective with a success rate of 92-96% if performed accurately.[3]

Chalazia or meibomian cysts are lipogranulomatous lesions in the eyelids caused by the obstruction of meibomian glands. Generally, they are painless, non-contagious and do not affect vision. However, they can cause cosmetic distress, secondary infections, and rarely, if significant in size, can result in astigmatism, higher order aberrations and potentially amblyopia in the paediatric setting.[4] Chalazia are one of the most common eyelid lesions diagnosed not only in ophthalmological settings, but also in general practice and emergency departments, therefore efficient management is important.[5] The reported rate of spontaneous resolution of chalazia with the use of hot compresses in the adult population ranges from 25-50%[6,7,8] but there is no published data specifically for the paediatric population. Due to the high resolution rate with conservative management, in combination with the risks involved with general anaesthesia for surgical intervention, the standard practice for treatment of paediatric chalazia involves warm compresses and massaging of the lump. There is also evidence that the earlier conservative management is initiated, the higher the chance of a resolution.[6]

Both conditions are routinely neither vision nor life-threatening and therefore when referrals for these conditions are received by the ophthalmology department they are usually triaged as Category 3 appointments. This would suggest an appointment within 12 months however, unfortunately, the scheduling of some patient's initial appointments exceeds this timeframe because of heavy demand. Additionally, during the initial ophthalmology examination parents are encouraged to initiate conservative management before surgical intervention is considered. If these conditions do not resolve with conservative management then surgery may be performed as a second line of management.

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Paediatric ophthalmology is a highly specific area of medicine and therefore ophthalmology departments at tertiary children's hospitals are often required to service very large geographical areas with populations to match. Demand for service from ophthalmology departments usually exceeds capacity and consequently it is difficult to schedule initial appointments within the recommended time frames. This means that there is a continual need to find innovative ways to maximise clinic efficiency, including new models of care and full utilisation of orthoptists' scope of practice to help with the burden on consultant ophthalmology clinics.

Orthoptic-led paediatric chalazia clinics have been developed in other health services with success. Whilst Bedi & Pilling[9] described a face-to-face clinic, they similarly suggested conservative management be prescribed as a first line of treatment. During this study it was found that none of the 24 children who were seen in the orthoptic-led outpatient clinic went on to require surgery, reinforcing the premise of a high resolution rate with conservative treatment. Jackson and Beun[10] reported on an ophthalmic nurse-run chalazia clinic. This clinic demonstrated further that providing nurses and allied health professionals with adequate training to expand their scope of practice resulted in adequate care equivalent to that of a medical practitioner.

An orthoptist-led phone clinic has been implemented at the Queensland Children's Hospital with the purpose of contacting the families and carers of patients with these conditions in order to provide education regarding conservative treatment and potentially resolve the issue before presentation to clinic. It has importantly also been designed to be a valuable screening tool for the detection of more serious pathology to ensure that this is addressed in a timely manner.

THE PHONE CALL CLINIC

Prior to the development of the phone call clinic, consultants responsible for triaging referrals were asking orthoptists to call patients and referrers to gain more information about the patient's condition and to encourage the initiation of conservative management. This ad hoc process was eventually formalised to a dedicated phone call clinic. Guidelines were produced by the consultant ophthalmologist and orthoptist, including the information to be discussed and the follow-up process. Red flag questions were designed to help screen for more serious pathology requiring a more urgent review, including differential diagnoses such as congenital glaucoma and orbital cellulitis. Patient information handouts about NLDO and chalazia were created for distribution to the parents following each phone call. The orthoptist received appropriate training prior to commencing the clinic.

The NLDO and chalazion phone call clinic began in February 2017. The clinic is conducted on a weekly basis in the ophthalmology department at Queensland Children's Hospital when adequate staff are available. The four-hour clinic includes approximately 12 patients per session and are a combination of review and initial phone consultations. These clinics are booked concurrently with a consultant clinic so that if clinical advice is required then it is readily accessible.

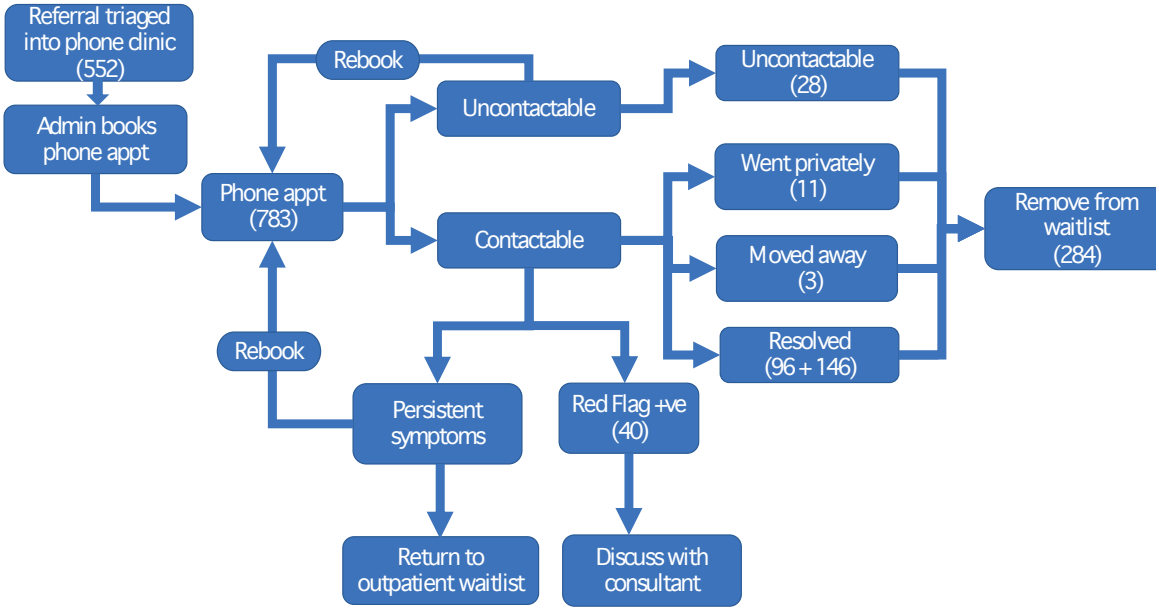

Figure 1. Patient pathway and numbers for the Orthoptic Phone Call Clinic at Queensland Children's Hospital.

The referral pathway has evolved with the formation of the clinic. All referrals received by the eye clinic are triaged by a consultant ophthalmologist and those deemed to be appropriate are redirected to the Orthoptist Phone Call Clinic waitlist. Initially, during the first year of the phone clinic, the ophthalmology waiting list was also screened by an orthoptist and any Category 3 referrals for these conditions were redirected to the phone call clinic too. Patients were advised through the hospital text messaging service to expect a call with the date and time.

During the phone consultation the orthoptist first introduced themselves and explained the purpose of the phone call, then took a detailed medical history concerning the condition and their general health. The nature of the suspected condition was explained and advice on conservative management was dispensed. This included how to keep the eye clean with lid hygiene measures and how to perform massage to help resolve the issue. These instructions were provided on an information sheet sent to the patients via email or post. Patients were also advised that they could send a photo via email for further assessment. It was important for both the parent and the clinician to be aware that without seeing the patient's ocular condition in person, a definitive diagnosis could not be made and therefore this must be disclaimed to the family.

Additionally, to help identify more serious pathology red flag questions were created. For the patients with suspected NLDO the red flag questions aimed to identify whether the patient was unusually photophobic; appeared to have asymmetrically proportioned eyes or eyes that appeared larger than normal; and whether the cornea appeared cloudy or hazy. This line of questioning was designed to detect congenital glaucoma and corneal pathology, which would warrant an urgent review. In suspected chalazia cases, the questions hoped to ascertain whether the lesion was painful, large enough to block the patient's vision, appeared to be infected, or was also associated with conjunctival injection. If there was a positive answer to any of these questions, then the case was discussed with an ophthalmologist.

The information received from each phone call was logged on the patient's electronic medical record including any follow up required such as the receipt of clinical photos or discussions with an ophthalmologist. If the condition had resolved between referral and initial phone call and there were no further concerns with the eyes or vision, then the child was removed from the ophthalmology waiting list. If the condition had not resolved, then conservative management was to be attempted and a review phone appointment was organised for two months. If the condition still had not resolved, then the patient was either returned to the general ophthalmology waitlist according to the date of initial referral or planned for a further phone call. Another phone call appointment review was only organised if there was still a strong likelihood that conservative management could be effective. This would typically include children with a chalazion reducing in size or with NLDO under the age of 12 months.

RESULTS

The retrospective review included 552 patients who were part of the phone call clinic during the period February 3rd 2017 to June 10th 2019. There was a total of 783 phone call appointments booked into the phone call clinic for 552 patients. Two hundred and eighty-three of the patients were male (51.1%) and 269 were female (48.9%). The ages ranged from 7 weeks to 17 years, with a median age of 17 months. In this study there were 196 referrals for chalazia, including 'eye lid lumps' and 'cysts'. There were 350 referrals for suspected blocked tear ducts including 'recurrent conjunctivitis' and 'sticky eyes', and an additional six referrals which did not easily fit into either category.

Of these 552 patients contacted, 96 (17.3%) had resolved between the date of referral and the first phone call appointment. At the time of publication, 54/552 (9.8%) were currently being monitored via the phone call clinic and 43/522 (7.8%) were awaiting an outpatient clinic appointment. These 97 patients were therefore excluded from the rest of the data as we do not yet know their outcome.

Of the remaining 455 patients, 146/455 patients (32.1%) resolved during the time they were being monitored on the phone clinic or prior to their outpatient appointment and were subsequently discharged. A further 11/455 (2.4%) patients chose to seek care in a private setting; 3/455 (0.7%) moved interstate; and 28/455 (6.2%) were uncontactable.

With the assumption that each of the aforementioned patients would have failed to attend their appointment or attended unnecessarily, we were able to better utilise 284 ophthalmology clinic appointments over this 28-month timeframe.

In addition to this, 83/455 (18.2%) were being seen by the ophthalmology team for ongoing management of the referred condition (including surgical intervention) or other incidental findings such as refractive error and 88/455 (19.3%) had been discharged by the ophthalmology department following at least one outpatient appointment.

The red flag questions and clinical history taking helped to identify patients on the waitlist who might need a more urgent review. During the period documented in this study there were 40/552 (7.2%) patients who were positive to a red flag question and brought into an outpatient appointment within 2 weeks. None of those were diagnosed as an ocular emergency, such as congenital glaucoma or orbital cellulitis.

DISCUSSION

Overall, more patients benefitted from the ophthalmology department's resources with no additional staff or resources required. Despite this, the workload of the orthoptists was not greatly affected due to careful scheduling of clinics.

The new clinic was beneficial to the ophthalmology department because it reduced the number of patients requiring face-to-face appointments. Subsequently, these appointments were available to be utilised for other waitlisted patients, leading to a reduction in the waitlist numbers and the waiting time for initial appointments.

The new clinic was also positive for the patients and their families. The clinic allowed the family to gain an understanding of their child's eye condition, and to receive instruction regarding conservative management at home. It was also a good opportunity to explain the options to parents who might have been interested in being managed in the private sector.

The inconvenience and associated costs of attending paediatric appointments can often be overlooked. It can be especially difficult in the public sector where there is little flexibility with appointment scheduling. For each paediatric appointment, usually a parent or guardian requires a day off work. The phone appointment can be more convenient for these families who struggle to be available, whilst also alleviating the cost of travel, parking and possibly accommodation. This is a significant consideration given that in Queensland some patients are required to travel well up to 1,800 km to reach the Children's Hospital. This is frequently at the expense of Queensland's Patient Travel Subsidy Scheme which provides assistance for patients and their carers. The average cost to Queensland Health through this scheme is $1,100 per claimant and in 2017 the cost totalled over $80 million.[11]

Participation in this clinic did not result in a longer wait time for patients requiring a consultant opinion. If the condition did not resolve during the phone call clinic care period, they were returned to the general waitlist with the date of their initial referral determining their place on the waitlist. Therefore, there was no delay in appointment waiting time. However, a small number of parents did still consider this waiting time to be excessive and expressed dissatisfaction with the process.

There are some difficulties associated with the phone call clinic. The phone calls are scheduled during outpatient hours which can be difficult if parents have the same work hours and are unable to use their phones. This was a likely contributing factor to the low success rate of contact on the first attempt. A further factor was the challenge of non-English-speaking parents with the need to coordinate interpreters. Whilst a phone conversation can often extract a lot more information than a referral can provide, it can still be difficult to assess severity and confirm a diagnosis with varying levels of parental understanding and concern.

This successful model of care could also be expanded with the correct framework and training to a larger range of ocular pathologies through telehealth and outpatient appointments. Currently in the initial planning phase, there is a pilot project to create a platform on the electronic medical records where photos can be uploaded directly and reviewed by clinicians with authorisation to view the medical record. This next step could greatly improve the triaging process to more accurately prioritise patients on the long waitlist.

The demand for effective and efficient triaging clinics is constantly increasing and orthoptists are the ideal eyecare professional to be used in these screening models to help combat the growing public health burden.

CONCLUSION

Through this retrospective review, the success of the new orthoptic phone call clinic has been well demonstrated. This new model of care has been a positive change for both the efficiency of the department and providing better patient care and access. Thus, it is recommended that this clinic be implemented in other ophthalmology departments facing the same accessibility issues. The phone clinic demonstrates orthoptists have an increasingly important role in patient care, particularly in the public health sector to help address this heavy burden.

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Does Health-Related Physical Fitness Differ Amongst Visually Impaired and Fully Sighted Young People?

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ABSTRACT

Introduction: Visual impairment is said to pose a barrier to everyday tasks, including physical activity. Physical activity can promote teamwork, socialisation and improve health and skill-related physical fitness. Fitness is important when participating in sport and exercise and is also a key facilitator in completing everyday tasks with ease. There are five components of health-related fitness: cardiorespiratory fitness, muscular strength, muscular endurance, body composition and flexibility. The aim of this systematic review was to determine the difference, if any, in health-related physical fitness levels of children and adolescents with a visual impairment when compared to fully sighted children and adolescents.

Methods: Comprehensive database searches of CINAHL, Embase and MEDLINE were undertaken to identify studies relating to the aim outlined above. Quantitative data was sought in relation to each of the five components of health-related fitness. Data was critically appraised, and bias addressed. A narrative synthesis, without meta-analysis was performed.

Results: Of the 342 studies screened, six were deemed eligible for inclusion. No conclusion was drawn with regards to muscular strength/endurance, body composition or flexibility due to the small amount of data collected. There were positive correlations found with regards to cardiorespiratory fitness and level of vision, with most studies indicating poorer fitness amongst the visually impaired groups. The heterogeneous nature of these findings did not allow for conclusiveness. Limitations of the included studies and this review were explored.

Discussion: Overall, despite consistent patterns in the findings, further study is needed to determine the difference in each of the health-related fitness components amongst the two groups.

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INTRODUCTION

The World Health Organization (WHO) includes both low vision and blindness in the definition of visual impairment (VI).[1] Whilst there is some discrepancy amongst definitions, WHO recognises blindness as having a visual acuity (VA) of 'less than 3/60, or a corresponding visual field loss to less than 10°, in the better eye with the best possible correction'. Low vision is subsequently defined as VA 'of less than 6/18 but equal to or better than 3/60, or a corresponding visual field loss to less than 20°, in the better eye with the best possible correction'.[2] Vision in sporting environments is usually classified according to International Blind Sports criteria B1, B2 or B3: B1 – VA less than LogMAR 2.60; B2 – VA between LogMAR 1.50 and 2.60 and/or a visual field less than 10°; B3 – VA between LogMAR 1.40 and 1.0 and/or a visual field less than 40°.[3] VI is said to pose a potential barrier to everyday tasks, including but not solely, physical activity.[4] Greguol et al[4] found lack of security, information relating to available programs and lack of motivation to be amongst the most significant barriers perceived by young individuals with a visual impairment. Physical activity is considered as any energy-expending activity produced by skeletal muscles, above resting levels.[5] Sedentary behaviour has been noted as a modifiable risk factor for an array of diseases including cardiovascular and osteopathic disease, diabetes mellitus and depression.[6] Physical activity, particularly in children can promote socialisation, teamwork, 'fair play, leadership, decision-making, trust'.[7] Social factors such as these could well prevent the social isolation that may arise as a result of VI.[8]

Physical fitness can be defined as 'a set of attributes that people have or achieve that relates to the ability to perform physical activity'.[9] There are five health-related components of physical

fitness that can attribute to its measurement: cardiorespiratory fitness, muscular endurance, muscular strength, body composition and flexibility.[9]

Depending on level of vision, participation in sporting or exercise programs may be limited due to lack of appropriate programs and equipment, lack of peers to train with and limited knowledge of how to include young people with VI in sports.[10] Adaptations to current activities may be necessary to allow for greater level of involvement, such as the use of tactile or auditory equipment or an increase in the contrast of equipment.[11,12] When implementing changes, it is important to consider the gross motor skills, such as walking, running or jumping, of the individual to allow for optimal post-adaptation performance. There is a positive correlation between level of physical fitness and motor competence.[13]

The aim of this review was to determine the difference, if any, in health-related physical fitness levels between children and adolescents with VI when compared to their fully sighted peers during participation in physical fitness tests. Societally, many recreational sporting programs are targeted to a younger demographic and so the focus of this review will be amongst children and adolescents. There is currently no systematic review relating solely to this specific topic.

METHODS

Eligibility criteria

The following study designs were eligible for inclusion: non-randomised control trials, cross-sectional studies, cohort studies and case-control studies. Only papers in the English language with results relating to human subjects aged 1 to 18 years were included. Participants were classified as having a visual impairment, either blind or low vision, without comorbidities, and the control group as fully sighted. Any unpublished results were excluded. Results of included articles were required to contain objective quantitative results relating to one or more health-related physical fitness component.

Participants: The review included children and adolescents aged 1 to 18 years with a visual impairment and matched fully sighted controls.

Exposure: Participants were exposed to tests of health-related physical fitness, including cardiorespiratory testing, body composition, muscular strength and endurance, and flexibility.

Outcomes: The outcome of interest was the difference in health-related physical fitness levels between visually impaired children when compared to their fully sighted peers. Outcome measures included at least one of the five health-related components of physical fitness: cardiorespiratory fitness, including maximum oxygen uptake (VO2 max), heart rate and breath rate/respiratory rate; body composition, including body fat percentage and skinfold; muscular strength; muscular endurance; and flexibility.

Identification of studies

Electronic searches of the following online databases were conducted: CINAHL, Embase and MEDLINE, with searches inclusive of all articles, 28th September 2018 and prior. Search terms included a combination of 'vis* impair*' and 'physical* activ*' or sport* or exercis* or fitness*. No restrictions were placed on date of publication, however searches were limited to human subjects and English language. Limitations were placed on age group with MEDLINE and CINAHL limited to 2 – 18 years and Embase limited to 1 – 17 years, owing to varying database subcategories.

Study selection

Two authors (RS and MV) independently reviewed the titles and abstracts identified in the search; irrelevant articles were excluded. Remaining articles were then collated, and duplicates identified and removed. The remaining articles were screened, and exclusions were made based on the eligibility criteria. Articles were obtained directly from database links and if necessary, via a university library document delivery. Articles were referenced and sorted using Endnote X9 (Clarivate Analytics).

Data extraction and critical appraisal

A comprehensive pre-developed data extraction form was used to analyse and extract relevant data. The items in the data extraction form included:

- Study design (and relevant reference details)
- Participant characteristics (age, gender, level of vision)
- Specific exposure type (specific fitness test and location undertaken)
- Outcome measures
- Methods used to analyse data
- Results of study relating to outcome measures
- Inclusion/exclusion

The key findings are detailed in Table 1.

Following the completion of the study selection, appraisal of the remaining studies was performed using the Joanna Briggs Institute (JBI) critical appraisal tools.[14,15] The tools assessed the relevance of the articles with regards to the established eligibility criteria, as well as the validity and reliability of the articles. Depending on the type of study, the relevant checklist was utilised. Quality was assessed based on the validity of study results.

Data synthesis/analysis

For the outcome of interest, objective measurements were sought. Quantitative results were compared against age-matched counterparts. Results were subdivided into the five relevant health-related physical fitness components. Where possible, analysis was isolated according to age, gender and level of vision. In most instances, a narrative synthesis was adapted from analysis of statistical significance (p value). Statistical pooling of results was not possible in this review due to the heterogeneity of results.

RESULTS

Search results

The total number of articles produced from the three database searches was 342. Following screening of title and abstract and removal of duplicates, 50 articles were identified as potentially eligible for inclusion. Following closer investigation of these articles, six were identified as being eligible for inclusion in the review, based on the established eligibility criteria. Total numbers and justifications were documented in a flowchart based on the principles of the PRISMA flow diagram (Figure 1).[16]

Study characteristics

Of the final six studies, a total of 593 participants were included, with ages ranging from 6 to 18 years (one study including only elementary school and junior high school students). Of these 593 participants, 270 were fully sighted and 323 were visually impaired, specific vision classifications utilised in each study are highlighted in Table 1. Publication dates spanned from 1982 to 2010. Studies were undertaken globally, in Canada, India, Netherlands, New Zealand, Poland and USA. Each study measured at least one component of health-related physical fitness, with many using various tests of fitness to do so (Table 1).

Study quality

Critical appraisal of the included studies was undertaken, according to the JBI critical appraisal tools for cohort and cross-sectional studies.[14,15] The study by Telles and Srinivas[17] followed a cohort study design. The respective JBI cohort appraisal tool was utilised.[14] Following the checklist, the study was found to be of good quality with a low risk of bias. Of particular interest in this study was the efficiency and completion of follow-up, reducing the risk of bias.

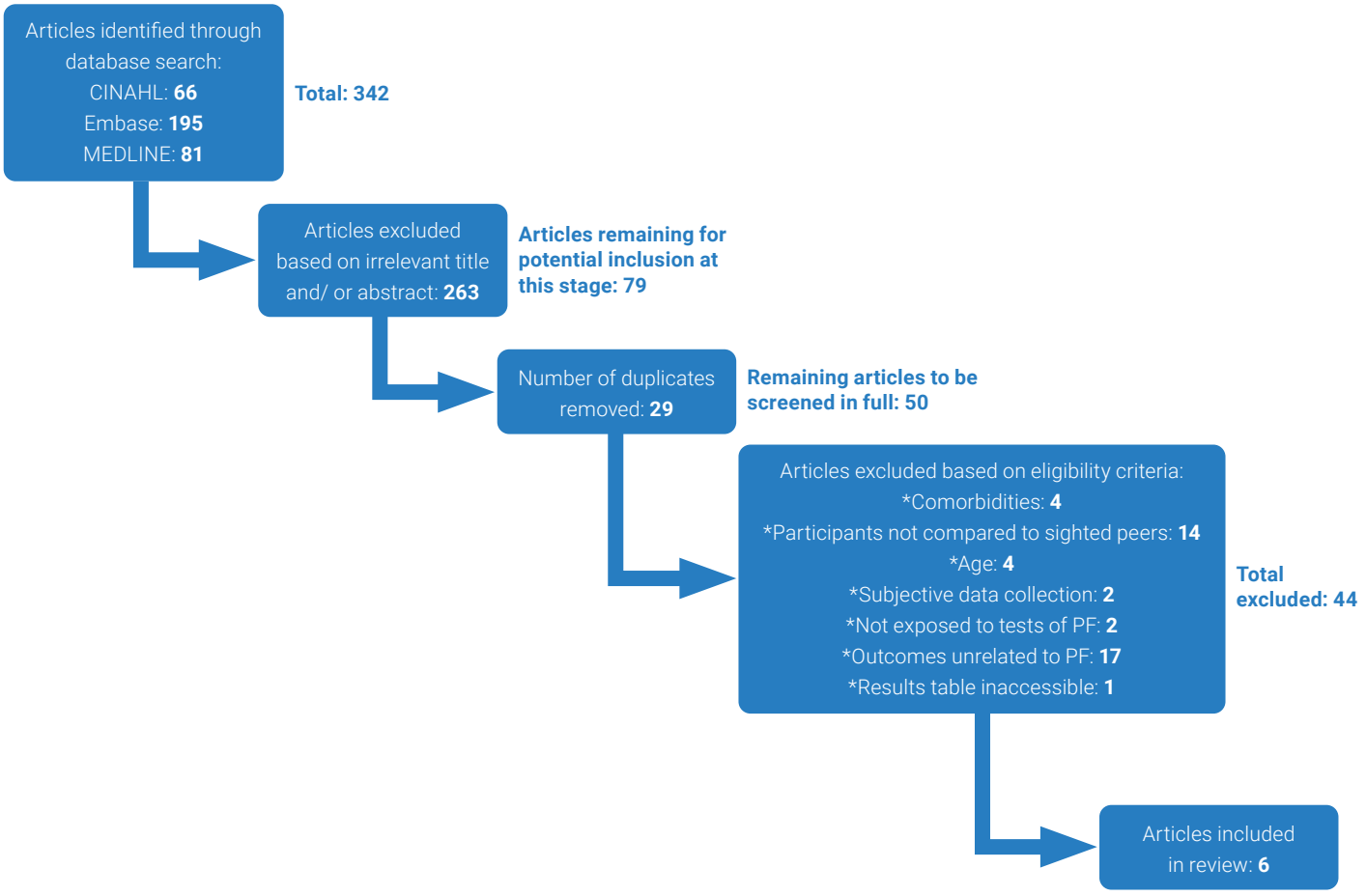

Figure 1. Study selection process.

The remaining five studies were assessed according to the JBI cross-sectional study tool.[15] Of these five studies, two were found to be under the influence of bias. The study by Zebrowska et al[19] was found to be of fair quality with a moderate risk of bias. The study by Seelye[20] was found to be of poor quality with a high risk of bias. Justifications are highlighted in Table 1.

Meta-analysis

The highly heterogeneous nature of the included studies, with varying outcome measures and physical fitness tests administered, prevented the undertaking of a meta-analysis. Statistical analysis of the pooled data is likely to have compromised the validity of the review with unreliable extrapolation of data, particularly since the number of included studies, and subsequent participants was small.

DISCUSSION

Findings

Upon analysis of the six included studies, no definite conclusion could be drawn as to whether children and adolescents with a visual impairment have lower levels of health-related physical fitness than their fully sighted peers. Whilst the majority of results showed that participants with VI achieved lower scores across the five components of health-related physical fitness, these results were obtained from small sample sizes and the outcome measures and fitness tests were not consistent across the studies.

Cardiorespiratory fitness

Five studies measured various aspects of cardiorespiratory fitness.

VO2 max: Kobberling et al[18] and Zebrowska et al[19] measured VO2 max on a cycle ergometer (maximal and submaximal) and treadmill (maximal), respectively. Both studies found that sighted males had significantly higher uptake when compared to VI males. Hopkins et al[21] also measured maximal oxygen uptake on a treadmill, finding fully sighted participants as having higher VO2 max compared to their peers with VI, particularly those classified as B1. Whilst not stating a specific physiological indicator, Houwen et al[22] measured overall cardiorespiratory fitness during the 20-MST (20 Meter Endurance Shuttle Run Test). It was found that sighted participants performed noticeably better than those with VI. This maximal test is an estimate of VO2 max.

Heart rate: Hopkins et al[21] measured heart rate using the Canadian Home Fitness Stepping test (submaximal). Fully sighted individuals had significantly lower heart rates than those with B1, B2 and B3 visual impairment, with lower submaximal heart rate indicative of greater fitness. Kobberling et al[18] found heart rate pre-exercise, as well as during running (submaximal), to be considerably higher in both male and female participants with VI. Heart rate during walking (submaximal) was significantly higher amongst males with VI compared to their fully sighted counterparts. Whilst the measured maximal heart rate was lower in the VI groups, it was not statistically significant. Similarly, Telles and Srinivas[17] also found resting heart rate to be significantly higher in participants with VI.

Breath rate/respiratory rate: Telles and Srinivas[17] found resting breath rate to be significantly higher in VI participants.

Cardiorespiratory fitness was the most commonly assessed aspect of fitness. Whilst the results do indicate a possible pattern of children with VI having lower levels of cardiorespiratory fitness than their fully sighted peers, the evidence cannot be considered conclusive. The data in some instances varied based on gender, and the measurement types (VO2 max, heart rate or breath rate) were not consistent across all studies. Given that all studies measuring this component favoured fully sighted participants in terms of greater fitness, it prompts further study in this specific area to reach a definite conclusion.

Body composition

Three studies measured body composition using the included outcome measures. Kobberling et al[18] measured body fat percentage, with the outcomes deemed insignificant amongst the VI and fully sighted groups. Houwen et al[22] also conducted assessment of percentage body fat finding fully sighted participants to be statistically lower. Hopkins et al[21] found an inverse correlation between level of vision and skinfold thickness, with participants categorised as B1 having a significantly higher average thickness compared to fully sighted, B2 and B3 participants. The varying measurement types, limited number of studies and conflicting results suggest further research is needed. Consistent measurement types are necessary to reach a definitive conclusion as to whether there is a clinically inverse correlation between level of vision and body composition.

Muscular strength

Three studies measured muscular strength. Using the 'partial sit up' and 'sit up' test, Hopkins et al[21] and Houwen et al[22] found no correlation between level of VA and abdominal muscular strength. Houwen et al[22] found the difference in hand strength between persons with VI and fully sighted persons to be insignificant when tested with a hand grip dynamometer. Despite not being classified as statistically significant it is important to note however, that the fully sighted group averaged an extra four kilograms on muscular contraction than the VI group. Seelye[20] measured abdominal and back strength as part of the Kraus-Weber Minimum Physical Fitness test. The study compared three participant groups. Whilst the fully sighted and partially sighted groups had similar pass rates (95%, 85%, respectively), the legally blind group had a lower rate of 45%. These results

Table 1. Summary of findings

Study	Group demographics	Physical fitness component tested and results Statistical significance p<0.05	Quality (Q) and Risk of Bias (RoB) within study
Hopkins et al, 1987[21] New Zealand (cross- sectional study)	**Experimental group** 27 participants (13 M, 14 F) *B1 (11), B2 (7), B3 (9)* **Control group** 27 participants (13M, 14F) **Age range** 7-17 years	**Cardiorespiratory fitness** FS lower HR (p<0.001) FS higher VO2 max (p<0.001) **Body composition** B1 higher skinfold (p<0.01) B2/B3 insignificant **Flexibility** Insignificant **Muscular strength/endurance** Insignificant	Q: good RoB: low
Houwen et al, 2010[22] Netherlands (cross- sectional study)	**Experimental group** 60 participants (40M, 20F) *20/400<BCVA<20/200 (16)* *20/60<BCVA<20/200 (44)* *Slight peripheral VF loss (4)* *Slight central VF loss (7)* *No VF loss (49)* **Control group** 60 participants (40M, 20F) **Age range** 6-12 years	**Cardiorespiratory fitness** FS performed better (p=0.03) **Muscular endurance_** Insignificant **Muscular strength** FS jumped further (p=0.01) Grip strength insignificant **Flexibility** Insignificant **Body composition** FS % body fat lower (p=0.02)	Q: good RoB: low
Kobberling et al, 1989[18] Canada (cross-sectional study)	**Experimental group** 30 participants (20M, 10F) *B1 (9), B2 (7), B3 (14)* **Control group** 30 participants (20M, 10F) **Age range** 12-16 years	**Cardiorespiratory fitness** M VI lower VO2 max (p<0.05) M & F VI higher rest and running HR (p<0.05) M VI higher walking HR (p<0.05) **Body composition** Insignificant	Q: good RoB: low
Seelye, 1983[20] USA (cross- sectional study)	**Experimental group** 74 participants *LB (37), PS (37)* **Control group** 37 participants **Age range** Elementary and junior high school students	**Muscular strength** Pass rates FS- 95%, PS- 85%, LB- 45% **Flexibility** Pass rates FS- 95%, PS- 73%, LB- 49%	Q: poor RoB: high (specific vision classifications not identified, single author, limited data regarding participant recruitment, gender breakdown not mentioned, conclusions based on visual inspection of data rather than statistical analysis)
Telles & Srinivas, 1998[17] India (cohort study)	**Experimental group** 28 participants *Grade 0: NPL* *Grade 1: PL* *Grade 2: HM* *Grade 3: CF* **Control group** 28 participants **Age range** 12-17 years	**Cardiorespiratory fitness** VI higher resting HR (p<0.05) VI higher resting BR (p<0.01)	Q: good RoB: low (gender breakdown not mentioned)
Zebrowska et al, 2007[19] Poland (cross- sectional study)	**Experimental group** 104 participants **Control group** 88 participants **Age range** 10-18 years	**Cardiorespiratory fitness** FS M higher VO2 max (p<0.01)	Q: fair RoB: moderate (inconsistent participant tallying throughout, specific vision classifications not identified, unequal group sizes)

Note: M = male, F = female, FS = fully sighted, BCVA = best corrected visual acuity, LB = legally blind, PS = partially sighted, NPL = no light perception, PL = light perception, HM = hand movements, CF = count fingers, HR = heart rate, BR = breath rate.

may indicate lower strength rates amongst visually impaired children and adolescents, with a possible positive correlation between level of vision and muscular strength. Conflicting data and small sample sizes measuring different areas of the body highlight the need for further study in this area.

Muscular endurance

Two studies tested muscular endurance using the 'partial sit up' test (the latter differing in name: 'sit up' test).[21,22] The sit up tests are a measure of both muscular strength and endurance, and as such , results are according to those above. Hopkins et al[21] found no correlation between level of vision and muscular endurance. Houwen et al[22] found the difference in muscular endurance of the abdominal muscles to be statistically insignificant between the two groups. Whilst similar findings were obtained, data cannot be generalised on the basis of two studies, with small sample sizes.

Flexibility

Two studies tested flexibility using the 'sit and reach' test.[21,22] One study simply stated that flexibility did not correlate with level of vision, and the second yielded identical results between both groups. A third study tested flexibility with the 'toe touch' test. This test made up one fifth of the Kraus-Weber Minimum Physical Fitness test.[20] These researchers reported a difference between the three groups with a pass rate of 95% in fully sighted, 73% in partially sighted and 49% in legally blind participants. From this, despite the studies administering similar test types, the conflicting result from the respective third study suggests that more research is needed in measuring flexibility levels amongst youths with VI to confirm whether or not there is a positive correlation between level of vision and flexibility.

Strengths/limitations:

The results found and collated in this review were influenced by initial database limitations. Restriction of non-English publications and the searching of only three databases may have excluded potential articles for inclusion in the review. A key inclusion criterion was the comparison of persons with VI to fully sighted participants. Whilst this did ensure reliability of comparison between the two groups, given rigorous matching and identical testing environment, it may have prevented a greater volume of credible evidence comparing VI to standardised age norms.

None of the included study designs were that of a randomised control trial, therefore the studies were susceptible to participant recruitment bias. All the included reviews did however contain control and experimental groups, obtained by matching according to age and anthropometric characteristics allowing for greater comparative reliability. Inclusion of only six studies, each with only a small number of participants, may limit the ability of the data to be applied into practice as it may not be representative of the general population. Health-related physical fitness contains five varying components, each with various valid measurements. The included studies, in most instances, utilised different measures of fitness components and used varying fitness tests to establish these measurements, leading to inconsistent data that could not be reliably pooled. It is recommended that future studies narrow the searches to individual components, such as cardiorespiratory fitness only, and their specific measurements within each component, ie VO2 max. Whilst most of the articles were of good quality with low bias, articles by Seelye,[20] and Zebrowska et al[19] contained potential biases, affecting their quality. These potential biases have been highlighted in Table 1.

Contextualisation of findings

There is suggestion in the literature that children with VI participate in less physical activity than the recommended age-related norms.[21,23] Greguol et al[4] found factors contributing to lower levels of participation to include lack of motivation and information regarding available programs, as well as security. Given the findings in this review, there may be evidence to suggest that children and adolescents with VI also have lower levels of cardiorespiratory fitness than their fully sighted peers. Whilst the results of the other four components of physical fitness were not extensive and easily comparable, individual results were generally favoured towards the fully sighted groups in terms of greater performance. If indicative of the greater population, this lesser participation in physical activity may have resulted in lower levels of physical fitness, due to limited opportunities to train and improve fitness levels. Participating in general activities such as rope jumping[24] or specific blindsports such as goalball for example[25] can have the capacity to improve physical fitness levels amongst VI children and adolescents. Enhanced engagement of this particular demographic in existing physical activity programs or further implementation of blindsports programs may be beneficial in improving participation levels and therefore health-related physical fitness levels. Improving these levels and promoting a healthy, active lifestyle at a young age could reduce chronic health conditions later in life and promote social development at a young age.

It is important also to note findings in the study by Kobberling et al[18] regarding oxygen consumption and energy expenditure. Both male and female participants with VI were found to use more oxygen whilst walking and running than the fully sighted participants. The suggestion from previous authors was that individuals with VI took a higher frequency of steps, with each being of shorter stride length, thus requiring more oxygen and perhaps leading to an earlier onset of fatigue.[26-28] Adapting activities based on gait and motor competence could be a useful tool in sparing oxygen use and delaying fatigue and improving one's physical fitness levels. Telles and Srinivas[17] found an increase in diastolic blood pressure, resting heart

rate and resting breath rate in individuals with VI. Factors such as fear of falling and injury may be responsible for these findings.[23,29] From this, it can be deduced that factors such as fear and biomechanics may also be responsible for poorer physical fitness outcomes upon testing. In addition to generally addressing lack of participation, it is also recommended that future studies address concerns regarding physical activity on an individual level and personalising adaptations.

CONCLUSION

The findings of this review indicate the necessity of further research into the effects of VI on muscular strength/endurance, body composition and flexibility. The results regarding cardiorespiratory fitness highlight that there may be a positive correlation between level of vision and this particular health-related fitness component. If further research is to confirm this correlation, conducting further studies measuring both participation in physical activity and consequent physical fitness levels of the respective individuals may also be recommended. Whilst a growing number of blindsports opportunities have been noted in community sport settings, these findings may be further cause to implement additional programs or enhance these current opportunities.

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Paediatric Laser Pointer Induced Retinopathy in a Successfully Treated Amblyope: A Case Report

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ABSTRACT

A 14 year-old male presented with a two-week history of blurred vision and a central scotoma after having a laser shone into his left eye. The patient had a significant previous ocular history of an infantile non-accommodative right esotropia for which he had amblyopia therapy and strabismus surgery. The patient's amblyopia had been successfully treated with part-time occlusion resulting in equal vison of 6/6 in each eye, with a residual right micro esotropia. Clinical examination from two weeks to six months post injury revealed reduced left vision and a central scotoma which did not improve. Optical coherence tomography and fundoscopy revealed focal atrophy of the photoreceptor layer at the fovea. The patient switched fixation and now has a left micro esotropia and can maintain 6/6 vison with the use of his previously amblyopic eye. This case highlights the importance of both amblyopia treatment and the dangers of misused lasers.

Keywords: amblyopia, laser pointer, retinopathy

INTRODUCTION

Retinal laser injuries have been reported in the literature, with varying short and long-term effects including retinal haemorrhage, macular hole and photoreceptor defects which can cause reduced vision and scotomas.[1,2,3] High-powered lasers can cause thermal burns and result in photocoagulation of the retinal tissue,[1] and as such, the World Health Organization recommends that any laser above a Class 2 rating has an unacceptable risk to consumers.[4] In most Australian states low-power lasers can be commercially used and imported if their power is <1mW (Class 2).[5] This level of laser has been determined to be safe for the duration of a blink reflex which is approximately 0.25 seconds.[4]

The case of a 14 year-old with previous successfully treated strabismic amblyopia, who later suffered a focal photoreceptor defect from a handheld laser pointer being shone into his fixing eye at school, resulting in a central scotoma and reduced visual acuity in this fixing eye is presented.

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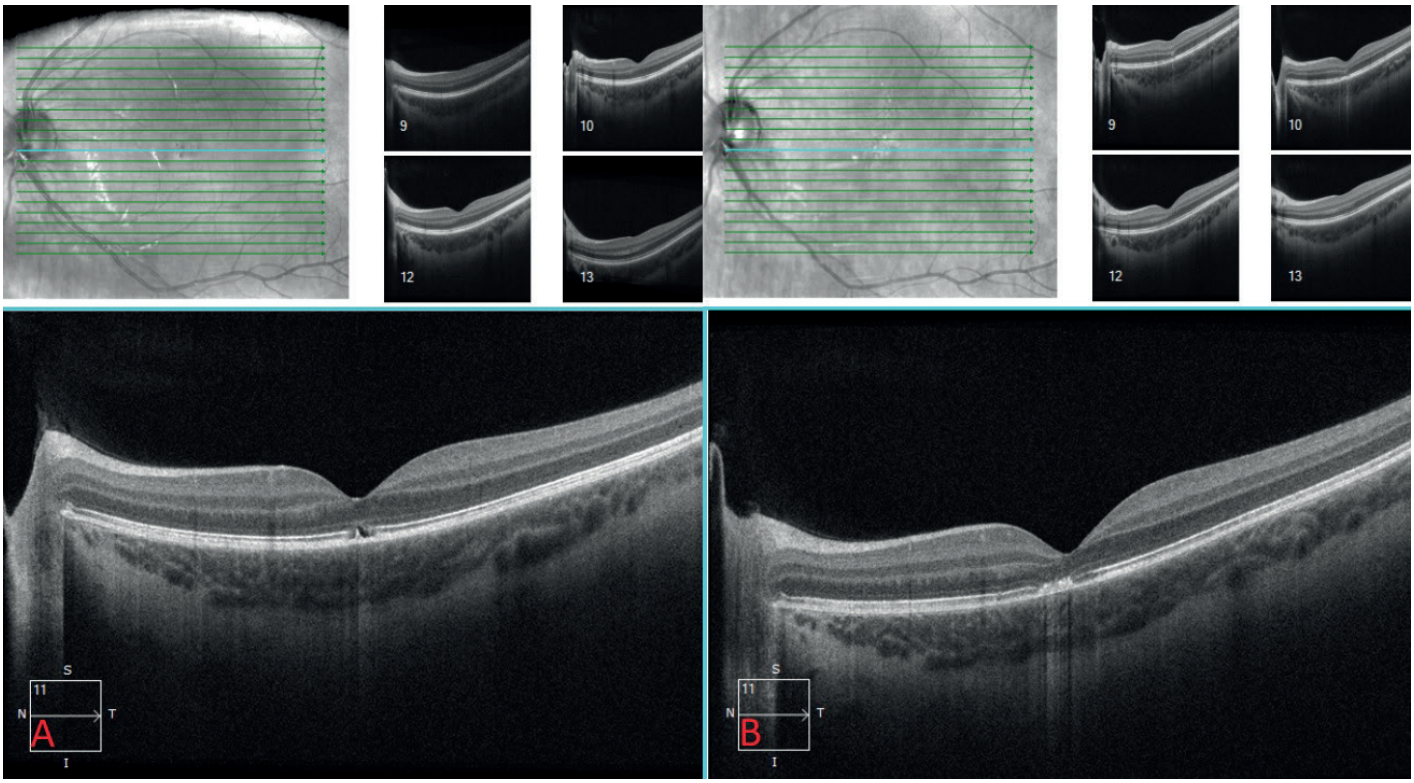
CASE REPORT

A 14 year-old male patient presented to our ophthalmology clinic 18 months early for his routine two-year strabismus review. He complained of a two-week history of blurred left vision and needing to look 'around an object/word' to identify it. His father added that his son returned from school complaining of these symptoms after he had had a bright torch shone in his eye. Approximately one week later, the patient admitted that it was in fact a green handheld laser pointer that was purchased online from the auction site eBay, that was shone into his left eye for approximately 5 seconds.

The patient's ocular history included infantile non-accommodative right esotropia for which he had been seen from birth in the public hospital system. The patient underwent two strabismus surgeries at eight years of age and has a residual right micro esotropia. He also had successful right amblyopia treatment of part-time left eye occlusion which resulted in equal vision of 6/6 in both eyes.

Upon examination the patient's Snellen chart visual acuity was right 6/6, left 6/9.5. At near he could read N5 with either eye but reading speed was slower with his left. The patient also described a central scotoma in his left eye and using eccentric fixation, explaining that he needed to 'look around an object to see it better'. A cover test at distance and near showed a right micro esotropia with dissociated vertical deviation. His intraocular pressure was normal, RE 16 and LE 13 mmHg. The optical coherence tomography (OCT) of the left eye showed



Figures 1A, foveal focal photoreceptor defect seen on optical coherence tomography two weeks post laser burn. **1B**, atrophy of photoreceptor layer eight weeks post laser burn.

a focal area of hyporeflectivity at the fovea (Figure 1A) and fundoscopy showed foveal pigmentary changes (Figures 2A and 3A), the right eye looked healthy (Figure 3B). The management at this appointment was to monitor the patient with review planned in six weeks.

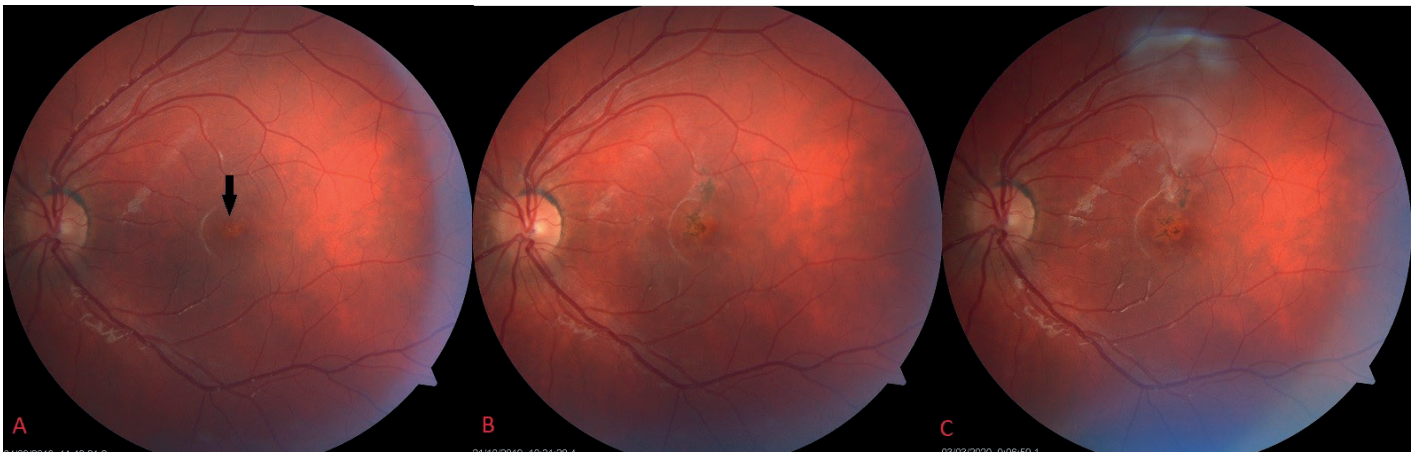
Six weeks later, the patient's left vision had reduced to 6/19 and he had switched fixation to a left micro esotropia. His fundoscopy showed atrophy at the macula (Figure 2B), also evident on the OCT which showed focal atrophy of the photoreceptor layer (Figure 1B). Management continued to be observational with no intervention and a follow-up appointment was booked for six-month's time.

At his six-month follow-up visit, visual acuity had improved slightly to 6/15, although subjectively the patient was still very bothered by his central scotoma. He maintained right fixation with a micro left esotropia and his fundoscopy was stable (Figure 2C).

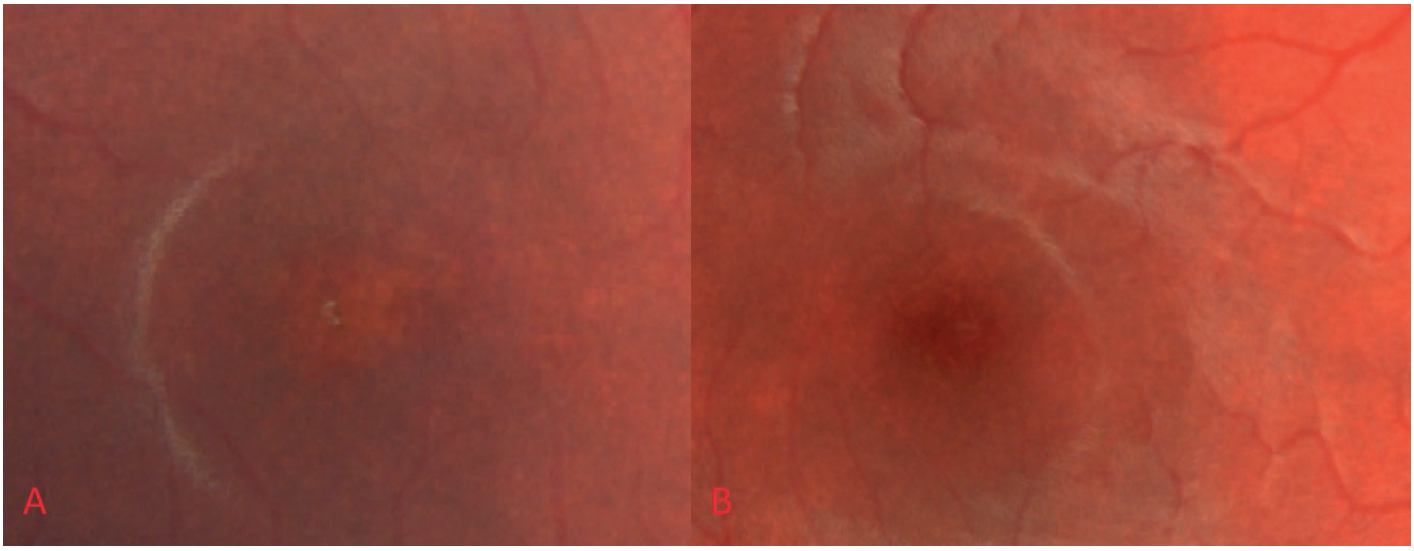
DISCUSSION

Previous studies have found that injury should not occur to retinal tissue from Class 2 (<1mW) lasers due to the protective mechanisms of the natural blink reflex.[2,4] However, our patient reported staring into the laser for up to 5 seconds eliminating this natural protection. While we do not know the power of the laser used in our case study, we do know that it was a green laser that was purchased online. It is well reported that shorter wavelengths (green 490 – 575 nm) cause more photothermal damage to the retina compared to longer wavelengths (red 635 – 750 nm) and thus may result in greater injury.[6] Additionally, it has been reported that lasers above Australia's legal import requirements are readily available at online sites. Importers package these items in ways that often pass through border security easily.[7] This has also been reported in other cases of laser maculopathy where children have been able to purchase lasers with powers of 150mW online and have suffered maculopathy as a result.[8] Our patient's obvious lack of understanding about the potential dangers from lasers demonstrate the need for wider reaching public health warnings about the risk of serious eye injuries and vision loss from laser pointers.

In patients with a focal photoreceptor defect from retinal laser burns there is limited treatment available. Subretinal haemorrhage has been reported in some cases of laser burns and this can be treated with intravitreal anti-vascular endothelial growth factor therapy.[8] The literature suggests that in most cases vision improves over the first month post exposure, but generally remains reduced.[1,8,9] Patients also report reduced perception of scotomas over time,[1] however this was not the case for our patient. Importantly for our patient's visual prognosis, he has had successful right amblyopia treatment. Untreated amblyopia would likely have resulted in permanently reduced vision potentially limiting work opportunities, social activities and his ability to drive, and resulting in a significant disablement for our patient post injury to his dominant eye.



Figures 2A, focal pigmentary change at fovea two weeks post laser burn. **2B**, atrophy at the macula eight weeks post laser burn. **2C**, stable fundus image six months post laser burn.



Figures 3A, magnified view from Figure **2A** of focal pigmentary change at fovea two weeks post laser burn. **3B**, healthy right eye comparison.

CONCLUSION

This case highlighted not only the importance of regulating the sale and importation of laser products, but also the value of paediatric eye care, specifically amblyopia treatment. Despite receiving damage to his dominant eye resulting in decreased vision and a central scotoma, due to previous successful amblyopia treatment this patient maintained excellent eyesight resulting in minimal impedance on daily activities by relying on his once amblyopic eye.

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Intraoperative Floppy Iris Syndrome in Association with Tamsulosin-Hydrochloride Medication: A Case Study

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ABSTRACT

Intraoperative floppy iris syndrome (IFIS) is a complication that can result from cataract extraction surgery causing immediate and postoperative complications, which has been found to be commonly associated with current or prior usage of alpha1 receptor antagonists. These medications inhibit smooth muscle contraction, particularly targeting the smooth muscle of the bladder and the prostate. Alpha1 receptor antagonists have also been reported to relax the iris dilator muscle and subsequently lead to IFIS.

We report a case of an 81 year-old male patient who was on a regular dose of Duodart for his prostatic hyperplasia management who underwent a cataract extraction which resulted in postoperative complications. He was diagnosed with IFIS as well as a subluxed lens, an initially undiagnosed capsulorhexis tear and a posterior vitreous haemorrhage, which required a secondary repair procedure.

This paper reviews the effects of an alpha1 receptor antagonist on an ophthalmic patient undergoing cataract extraction and discusses how orthoptists can be involved in mitigating the risk of IFIS.

Keywords: intraoperative floppy iris syndrome, tamsulosin-hydrochloride, alpha blockers, cataract surgery complications

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INTRODUCTION

Intraoperative floppy iris syndrome (IFIS) is a complication which can arise during cataract extraction surgery[1] and is highly variable, occurring in 0.8% to 12.6%[2] of all cataract surgeries performed. It is characterised by an array of physiological observations which include a soft, loosely hanging iris stroma, irregular movement of the iris which can lead to the outward flow of the iris, the tendency of the iris to prolapse through surgical incisions and progressive pupil constriction intraoperatively despite prior mydriatic therapy.[3]

In 2005, Chang and Campbell[4] were the first to associate the development of IFIS with the use of tamsulosin-hydrochloride. Since then, a number of studies have supported this correlation[1-3,5,6] and it is suggested that between 2 and 9.09%[2] of patients using tamsulosin-hydrochloride develop IFIS.[7-9]

Tamsulosin-hydrochloride, commercially available in Australia as Flomaxtra or Silodosin (monotherapy medication) or Duodart (combination therapy of dutasteride and tamulosin), is an alpha1 receptor antagonist, used to treat symptoms of benign prostate hyperplasia (BPH). BPH affects men aged 60 years and older with 3 in 4 men affected by the age of 70.[10,11] Of those who develop BPH it is reported that approximately 10% require pharmacological intervention, such as alpha1 receptor antagonists, to improve symptoms and quality of life.[6]

This paper presents a case of a male patient who was being treated for BPH with tamsulosin-hydrochloride who developed postoperative cataract complications. The aim of this paper is to review the effects of tamsulosin-hydrochloride on ophthalmic patients and to discuss how orthoptists, through the use of thorough history-taking and clinical investigation, can play an important part in mitigating the risk of IFIS occurrence.

CASE REPORT

An 81 year-old male patient presented to a vitreoretinal clinic for a specialist postoperative B-scan of the left eye, due to the lack of visibility of the posterior segment after complicated cataract surgery and a secondary procedure. Initially, he had undergone a phacoemulsification procedure for a left posterior subcapsular cataract at another ophthalmology clinic. Postoperatively, he was diagnosed with left IFIS, a peripheral capsular tear and lens displacement. At the time of surgical intervention, he was on a regular dose of Duodart for the management of BPH. His general health was complicated by non-insulin dependent diabetes mellitus, hypercholesterolaemia, hypertension and he had a pacemaker. He was taking numerous medications for these conditions, including blood thinners, anti-hypertensives and blood glucose lowering drugs.

Due to the postoperative complications, he was returned to theatre to remove the subluxated lens and to insert a new sulcus lens. This secondary procedure was difficult and posed a significant risk due to surgical manipulation of the iris to add iris hooks for lens displacement rectification. With this manipulation, a left hyphaema and vitreous haemorrhage developed and a vitrectomy was performed to clear the haemorrhage. Postoperatively, he was prescribed a course of Acular and Prednefrin Forte drops and he was then referred to a vitreoretinal surgeon in our clinic for opinion related to his postoperative complications.

Postoperatively, his visual acuity was RE 6/9 (plano/-1.75 x 90°) and LE 6/36 (+4.50/-5.00 x 150°) which improved to 6/18 with pinhole. Whilst there was no indication in the patient's notes related to the refractive outcome of his left eye, it is worth noting that he had a history of left amblyopia which was most likely refractive and due to his poor acuity, an intraocular lens to correct the astigmatism may not have been indicated. Intraocular pressure was recorded as RE 14 mmHg and LE 27 mmHg. A pupil assessment revealed significant constriction of the left pupil, the left hyphaema had cleared and the intraocular lens was in central position. Optical coherence tomography was performed but could not be interpreted due to a poor view.

The ocular history of the right eye was unremarkable, other than a phacoemulsification procedure for a right posterior capsular cataract prior to the left cataract surgery, with no resultant complications. The patient was taking Duodart for a significant amount of time prior to both cataract surgeries, yet complications only occurred after surgery to his left eye.

DISCUSSION

This case highlights the surgical complications that can arise when a patient is receiving pharmacological intervention for BPH. The principal drug classes employed in the management of BPH are alpha1 blockers and 5α-reductase inhibitors.[12] This patient was on a regular dose of Duodart for the management of his benign prostate enlargement. Duodart is a combination therapy, consisting of dutasteride and tamsulosin-hydrochloride. Dutasteride is a 5α-reductase inhibitor and works by specifically decreasing the production of dihydrotestosterone and in turn reducing the rate of prostate enlargement or the prostate volume.[5] Tamsulosin-hydrochloride is an alpha1 adrenoceptor blocking agent which demonstrates selectivity for alpha1 receptors which have been shown to mediate the contraction of prostatic smooth muscle.[13] In the treatment of BPH, alpha1 blockers relax the smooth muscle of the bladder and prostate thereby decreasing the resistance along the bladder neck, prostate and urethra and improving the patient's symptoms. Ocular complications can arise when the alpha1 adrenergic receptors are blocked in the iris dilator muscle, preventing mydriasis during ophthalmic surgery. Research suggests that 5-alpha reductase inhibitors, however, do not appear to cause IFIS to any significant degree.[6]

In this particular case, Duodart most likely led to IFIS by causing relaxation of the iris dilator. As a consequence, his small pupils would have made it difficult for the surgeon to perform cataract surgery successfully and increased the risk of complications. The chain reaction of events also made it difficult to identify the peripheral capsular tear that occurred during the surgery leading to a delayed diagnosis of this condition. It is likely that this peripheral tear caused migration of the lens inferiorly, causing the subluxated lens and the need for a secondary procedure to address the tear and lens dislocation. The left hyphaema and vitreous haemorrhage noted during this second procedure were also likely related to the patient's medications. Hyphaema can be a complication due to iris trauma caused by IFIS, additionally his blood thinner usage would have exacerbated the bleeding.

The patient's postoperative complications are consistent with the literature.[1,3,4,6] Interestingly, a recent study of 39,144 cataract surgeries in a population of male patients with a history of tamsulosin-hydrochloride use, and of 378,611 patients not exposed to tamsulosin-hydrochloride, found that there has been a decrease in adverse events from the years 2003 to 2013.[1] Campbell et al[1] suggested that this improvement is likely due to the continuing education of ophthalmologists, increased awareness of the risks and of risk-modifying techniques and technological advancements.

Overall, the literature suggests that screening is essential in mitigating the risk of IFIS.[2,3] Taking a thorough medical history is considered the most effective way to identify at-risk patients and this case highlights the instrumental role of the orthoptist.[2,5,6] History taking should explore the use of alpha1 blockers for BPH or related conditions such as stones in the urinary tract. In addition, populations at risk, such as older men, should always be asked preoperatively if they have received any such intervention. It is also important to enquire about previous, as well as current treatment, as discontinuing alpha1 blockers has not been found to decrease the risk of IFIS completely.[6] Indeed because of this, and the questionable value of ceasing treatment, patients are not always asked to terminate their use of alpha1 blockers before a cataract extraction procedure.[3]

By orthoptists clearly identifying high-risk patients during medical history-taking, complications that arise from IFIS can be mitigated if orthoptists identified patients at higher risk by careful history taking in combination with surgeons planning prophylactic intraoperative measures. For example, mechanical pupil examination devices, viscoadaptive ophthalmic viscosurgical devices, fluidic parameter optimisation and intensive pharmacological pupil dilation can be used intraoperatively to avoid the complications of IFIS.[1,14] Whether used alone or in combination, these types of techniques are reported to improve the surgical success rate in patients with a history of tamsulosin-hydrochloride use.[14]

CONCLUSION

Alpha1 receptor medications, such as tamsulosin-hydrochloride, are recognised to increase the risk of IFIS. Commonly used alpha1 receptor drugs used in Australia are Duodart, Silodosin and Flomax. Given that the development of cataracts, the incidence of BPH and stones in the urinary tract, the use of alpha1 receptors increases with age in men, it is important to identify patients on tamsulosin-hydrochloride and other similar medications who are scheduled for a cataract extraction. A comprehensive medical history taken by an orthopist may identify the use of any alpha1 receptor antagonist medications. It is important to ask about any prior medications the patient was taking to minimise complications with ophthalmic treatment. The use of previous medications can make the difference between an uneventful or a problematic outcome.

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Editorial: COVID-19 Impact on Australian Orthoptic Clinical Practice

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Many would agree that compared to other countries, Australia has been labelled a pandemic success story. Our nation of 26 million has largely been willing to follow public health directions and our governments in general have allowed science to guide policy. By November 2020 and for the first time in almost 300 days, Victoria recorded zero active COVID-19 cases after its deadly second wave.[1] Since then, Australia continues to experience small outbreaks that have been managed effectively with public health measures, snap lockdowns and border closures.

When the World Health Organization declared the COVID-19 outbreak a pandemic in March 2020,[2] it was a very different story. Australia watched the rest of the world as several countries struggled to deal with the overwhelming number of cases. As cases increased in Australia, uncertainty fuelled anxiety amongst health care workers (HCWs). It was an unsettling time as reports of the growing number of infections in Europe flooded the news and early reports emerged in the ophthalmology space of evidence of SARS-CoV-2 on the ocular surface.[3,4]

The Australian Government responded rapidly to stay on top of the pandemic. By mid-March, the National Cabinet introduced widespread measures to protect the public including restrictions on social gatherings, physical distancing and contact tracing. In further steps, states and territories announced border closures and mandatory 14-day quarantine for travellers entering their jurisdictions.[5] Border closures impacted eye care service delivery in our cross-border towns, as well as the vital care needed for our regional and remote patients.[6]

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On March 25th, the National Cabinet acted on the advice of the Australian Health Protection Principal Committee to temporarily suspend all non-urgent elective surgery.[7,8] By cancelling surgeries, the National Cabinet acted to preserve vital reserves of medicines and important hospital resources, including personal protective equipment (PPE), to help prepare public and private health services for their role in the COVID-19 outbreak. There was common belief amongst governments and key peak bodies that a consistent national approach, which prioritised the health, safety and wellbeing of all patients and healthcare workers was necessary.

Cancellation of elective surgeries created a significant flow-on effect for orthoptists in clinical practice. Cataract is the second highest cause of vision impairment for both indigenous and non-indigenous older Australians and cataract surgery is the most common surgery performed by ophthalmologists.[9] In 2019 alone, Medicare reported that over 160,000 cataract surgeries were performed.[10] In general practice, much of our daily orthoptic clinical practice involves the assessment, diagnosis and care of pre- and post-operative cataract patients. Suddenly private ophthalmology and outpatient clinics were unusually quiet with exception of phones ringing and frequent exchanges regarding surgery cancellations and appointment rescheduling.

Whilst some public hospitals were slow to implement changes in ophthalmology outpatient settings, many private ophthalmology practices swiftly installed perspex screens at reception, sourced breath shields for diagnostic testing equipment and began the process of procuring rapidly dwindling sources of PPE and disinfecting products. The overwhelming volume of information from numerous sources highlighted the need to establish a 'single source of truth' for orthoptists to avoid confusion and misinformation. Orthoptists employed in the public health system adhered to state health department and hospital directives, but many in private ophthalmology practices relied on trickled down information from employers, practice managers or the Royal Australian and New Zealand College of Ophthalmologists (RANZCO).

Initially inconsistencies were seen in PPE guidelines across federal and state health departments as the debate about

the mode of transmission for COVID-19 continued and data was less clear around eye protection.[11] At the time there were also no nationally approved infection prevention and control (IPC) guidelines for allied health practice, and these were later developed by Allied Health Professions Australia in consultation with Orthoptics Australia for the Department of Health.[12] To seek clarification on specific IPC matters, Orthoptics Australia (OA) and Optometry Australia sought external advice from an infection control expert as there were still many unanswered questions and ambiguities about best practice for disinfection of some semi-critical devices such as applanation tonometer tips and how to safely perform visual fields in small rooms without adequate ventilation.

The disruptions to clinical practice continued on March 30th, when RANZCO introduced triaging guidelines for Fellows and other health professionals.[13] The guidelines intended to help preserve limited PPE, reduce movement of people and to help protect staff, patients and the wider community. However, the guidelines were prescriptive and left little to ophthalmologist or orthoptist discretion, often raised more questions, failed to address individual patient preferences and did not cater for our patients with low vision and blindness. The challenges were numerous as many orthoptists were tasked with triaging patient bookings and referrals. Many were tasked with triaging many hundreds of appointments.

There were added complexities with inconsistencies amongst ophthalmologists around criteria determining which patients fell into medium urgency categories and assumptions about who could manage telehealth consultations. It also did not take into consideration subjective levels of risk appetite across institutions, practices, ophthalmologists, orthoptists, staff and patients.

In order to continue vital care to many patients, the Federal Health Minister, Greg Hunt, announced the telehealth expansion to fight COVID-19.[14] As of March 30th, patients were able to access allied health practitioners via telehealth for bulk-billed services under existing Medicare items. However, Professor Michael Kidd, Principal Medical Advisor to the Department of Health, later announced that additional telehealth services applied to existing MBS item numbers only and there would be no expansion, despite the Prime Minister using wording such as 'universal access'.

Telehealth was widely promoted, however funding for allied health telehealth services including the provision of orthoptic services via telehealth was not adequately addressed. Orthoptics Australia, like many other allied health peak bodies at the time, sought assistance from organisations like Allied Health Professions Australia and Private Healthcare Australia to lobby private insurers, NDIS and DVA to ensure patients had access to orthoptic services via telehealth.

Much of the existing digital infrastructure systems at the time were not set up adequately for telehealth consultations and many of the platforms used were not optimised for virtual consultations. There were very few established guidelines on telehealth apart from in areas such as rural health for GPs and Orthoptics Australia along with other organisations needed to develop guidelines and gather resources to assist members.[15,16] Several allied health professions including orthoptists struggled with how to accurately or adequately assess patients via telehealth. In early 2020, very few Apps for testing visual acuity had been rigorously tested for use in telehealth and not many were practical or accurate in paediatric patients and for those with low vision and blindness.

By May 15th, minor easing of restrictions occurred, but the impact of the pandemic on orthoptists became a focus for OA. Some public hospital-employed orthoptists had been re-deployed into other non-clinical roles within the department or to roles within the other hospital departments. Quieter private clinics meant sessional or locum orthoptists had work hours reduced and sessions cancelled. Others were isolated from colleagues and friends working from home. OA together with the UTS Discipline of Orthoptics and in collaboration with the University of Liverpool undertook a survey to investigate the ongoing impact of the COVID-19 pandemic on orthoptic work and practice. There was a drive to capture timely information and the potential to share emerging innovative practice, not only within the orthoptic profession, but with other professions and health settings also. There was also a shared desire to consider the pressures on eye health care professionals and coping mechanisms under trying conditions.

Breaches in Victorian hotel quarantine in late May set off Victoria's deadly second wave and by August 2nd, the Premier had declared a state of disaster. More than 3,500 healthcare workers were infected during the second wave and many public hospitals in Victoria were severely impacted with HCWs off work, either sick or furloughed.[17] Orthoptists continued to be at risk of infection due to the nature of eye examinations and the proximity to the patient's face and the demographics of the patients in practice.

In 2020, the pandemic significantly altered orthoptic clinical practice. Today many COVID-19 protocols remain embedded in routine clinical practice. Infection prevention and control practices under pandemic conditions are better understood and innovations in telehealth and other digital technologies have accelerated changes in eye health care. Until the COVID-19 vaccine rollout is completed in Australia, many of the changes we see today will remain in place well into 2021.

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Selected Abstracts from the Orthoptics Australia 77th Annual Scientific Conference held online, 14th to 15th November 2020

TREATING DRY EYE DISEASE IN AN ORTHOPTIC-LED OPHTHALMOLOGY CLINIC

Zeeshaan Daruwalla

Dry eye disease can be caused by lack of the aqueous and/or oily layer of the tear film or dysfunction of Meibomian glands. Dry eyes can impact quality of life and reduce the quality of diagnostic tests performed in an ophthalmic clinic. Approximately 20% of adults suffer with dry eye disease. Whilst our understanding of the disease has greatly improved, the lack of standardised measurement for assessment and treatment efficiency leads to delay in appropriate management and suboptimal patient outcomes. There are several treatment modalities for dry eye syndrome depending on the clinical signs secondary to a patient's underlying pathology and subjective experience. Conservative treatment, beyond the commonly used ocular lubricants, includes modification of diet, application of heat to the lids, manuka honey drops and lid hygiene techniques. A new approach to treating dry eye in patients is the use of Intense Pulsed Light (IPL) therapy and whilst this is increasingly being used in the ophthalmic setting, there is a paucity of research in this area. The aim of this presentation is to describe and recommend a model of care in an ophthalmology clinic led by an orthoptist and supported by an ophthalmologist, with the ultimate aim of improving patient outcomes.

ECCENTRIC VIEWING STRATEGY: WHAT IS THE EVIDENCE?

Kerry Fitzmaurice

Following the introduction of the NDIS in Australia, interest in providing eccentric viewing training has increased as there is now a funding source to support it. However, a case needs to be made to support a recommendation for eccentric viewing training. Orthoptists are looking to the literature for evidence, however evidence is limited and the search needs to extend beyond the usual 5 to 10 years. In addition, due to the nature of vision rehabilitation agencies research is often practice-based and involves small numbers of participants. The published evidence rarely if ever meets the level of rigour commensurate with randomised control trials (RCT) and is often published in discipline-based journals or conference transactions thus not readily available.

Method: Literature search using databases such as Medline and CINAHL, in addition to Google Scholar and key conference transactions to identify a wide range of relevant papers. The results of reviewing a range of literature sources including those not readily available in the public domain were presented. Key findings from this review were reported to provide access to a consolidated reference to support the implementation of eccentric viewing programs.

THE PREVALENCE AND CAUSES OF VISION IMPAIRMENT IN CHILDHOOD

Mythili Ilango

Vision impairment is the sixth most severe global burden of disease impact. Although the majority of those with vision impairment are over the age of 50 years, childhood vision impairment accounts for 4% of the visually impaired in the world. Of the global costs associated with vision impairment and blindness, one-third of these costs are utilised by children's vision impairment. Numerous childhood ocular conditions including refractive error are correctable and other conditions such as amblyopia are preventable and treatable; however, the issue is whether they are detected early enough to ensure minimal impact through timely treatment. If preventable and treatable causes of vision impairment are identified and addressed early on, this could reduce the impact on the children's ability to learn, socialise and participate in daily activities as well as the global costs in having to support those with vision impairment. The current study aimed to identify the prevalence and common causes of reduced vision throughout childhood (3 to 17 years) as well as determining the impact of timely treatment in highlighting the importance of universal preschool vision screening.

THE ORTHOPTIST'S ROLE IN INHERITED OCULAR DISEASE

Diana Jelovic

As we prepare to welcome clinical trials for inherited eye disease, it is increasingly important for orthoptists to be aware of testing protocols and the patient information needed for their patients to be eligible for clinical trials. The phenotype/genotype correlation of genetic eye disease, inheritance patterns of disease, mandatory information required for trials was discussed and practical information for orthoptists to create patient pedigrees and interpret genetic reports was provided.

FREQUENCY OF RETINAL NERVE FIBRE LAYER THICKNESS MISCLASSIFICATION IN YOUNG HEALTHY ADULTS USING THE HEIDELBERG SPECTRALIS

Gareth Lingham

Background: Optical coherence tomography (OCT) software compares retinal nerve fibre layer thickness (RNFLt) to the manufacturer's built-in reference database and classifies a patient's RNFLt as within normal limits (WNL; RNFLt in top 95% of age-matched population), borderline (lowest 1-5%) or outside normal limits (ONL; lowest 1%). However, little is known about the representativeness of these normative databases. We compared the RNFLt in a population of healthy young adults in Western Australia to a normative database.

Methods: Participants were recruited from the Raine Study and Kidskin Study in Perth, Australia. All participants underwent a standard OCT protocol including RNFLt circle scan (Spectralis, Heidelberg Engineering, Heidelberg, Germany). Scans were excluded if not centred on the optic nerve or if an optic nerve pathology or uncorrectable segmentation error was present. Only participants of European descent were included. All confidence Intervals (CI) are 95%.

Results: After exclusions, OCT scans of either eye were available for 1,365 participants (262 Kidskin Study and 1,103 Raine Study participants). The mean age of participants was 21.5 years (range 19.1 to 30.0) and 51.0% (n=696) of participants were female. For right eyes, the frequency of a WNL classification was 92.0% temporally, 95.9% superotemporally, 92.2% superonasally, 99.1% nasally, 97.8% inferonasally, 97.1% inferotemporally and 96.5% for global RNFLt. For left eyes, the frequency of a WNL classification was 87.2% temporally, 92.1% superotemporally, 91.9% superonasally, 99.0% nasally, 98.7% inferonasally, 97.4% inferotemporally and 96.7% for global RNFLt. In the temporal sector, the frequency of a borderline or ONL classification was higher than expected for both the right (borderline=6.6% [CI: 5.2-7.8%]; ONL=1.4% [CI: 0.7-2.0%]) and left eyes (borderline=10.4% [CI: 8.9-12.1%]; ONL=2.4% [CI: 1.5-3.2%]) In the nasal sector, the frequency of a borderline or ONL classification was lower than expected for the right (borderline=0.8% [CI: 0.3-1.2%]; ONL=0.1% [CI:0.0-0.2%]) and left (borderline=1.0% [CI: 0.3-1.3%]; ONL=0.1% [CI: 0.0-0.2%]) eyes.

Conclusion: Participants in our study had thinner temporal RNFLt and thicker nasal RNFLt than the manufacturer's normative database leading to misclassification. These findings are important for interpretation of RNFLt measured by the Heidelberg Spectralis OCT.

LONG-TERM USE OF ANTI-VEGF FOR THE TREATMENT OF DIABETIC MACULAR OEDEMA IN AN OPHTHALMOLOGY PRACTICE

Czarina Obtinalla

Phase 3 clinical trials investigating vascular endothelial growth (VEGF) inhibitors on the severity and progression of diabetic macular oedema (DMO) have shown that patients have improvements in their visual acuity (VA). However, whether these outcomes can be achieved in a real-world clinical setting is not clear. The aim of this five-year retrospective observational study of 131 treatment naive eyes was to identify whether the visual outcomes could be replicated in the real world. Mean VA at baseline was 67.95 letters with significant improvement at year 1 and 2. The change at year 3 and 4 was not significant but for patients that remained on treatment at 5 years, VA improved on average by almost 9 letters. Patients were not able to approach and maintain VA demonstrated by clinical trials and this may be due to under-treatment of patients in the clinical setting.

HOW DO OPHTHALMOLOGISTS PERCEIVE THE LIKELY EFFECT OF ARTIFICIAL INTELLIGENCE IN THE AREA OF EYE CARE?

Philip Rothschild

Artificial intelligence (AI) is rapidly changing the world around us, with broad effects anticipated in many different industries. The field of ophthalmology is not immune to this, and in recent years there have been advances in using AI to assist with management of eye disease. Although there will likely be patient-related benefits in the development of AI within ophthalmology,

adopting these new technologies could result in significant upheaval for key stakeholders including ophthalmologists, orthoptists, and optometrists. However, the perspective of these stakeholders is not well known. We conducted a survey of ophthalmologists, dermatologists, radiologists, and radiation oncologists in Australia and New Zealand, and asked about their perspective of the impact of AI within their respective fields (n=632). There were 305 responses from ophthalmologists, which constituted 20.4% of the workforce. The majority (n= 224, 73%) believed artificial intelligence would improve their field of medicine, and that it would be less than 5 years until a noticeable impact was seen (n= 201, 66%). Most respondents also held that medical workforce needs would be impacted somewhat or to a great extent by the technology within the next decade (n=211, 69%). Ophthalmologists were likely to think that optometrists will be most affected by the introduction of AI to ophthalmology. They also had a lower bar for performance of AI systems when used for screening purposes by allied and other health professionals, as compared to AI systems that are used for diagnostic decision support by ophthalmologists. As experts in the operation of ocular diagnostic equipment, it is important for orthoptists to be involved in the deployment of any new technology. This presentation explored the perspectives of ophthalmologists on AI, and offered a brief perspective on what the likely effects of AI could be for orthoptists.

AUSTRALIAN CHILDREN WITH CVI – USING WHAT WE KNOW NOW TO IMPROVE FUTURE APPROACHES

Sue Silveira

Children with cerebral/cortical vision impairment (CVI) form the second largest group of children with vision impairment in Australia. By nature of their vision impairment, these children have diverse and often complex eye and vision conditions, and comorbidities such as additional disabilities and health conditions. It is therefore vital that the sector is well informed and prepared to offer timely, flexible and targeted early intervention and ongoing educational support. To enable this, clear information must be reported by ophthalmology clinicians to professionals working with children with CVI, to ensure an understanding of the nature of a child's visual function. This paper presented the key findings on 132 children with the primary diagnosis of CVI from the Australian Childhood Vision Impairment Register, including demographics, the journey from suspicion to diagnosis, levels of vision impairment and comorbidities. Although these findings reveal valuable health and vision profiles, they also demonstrate some of the shortfalls in detection, assessment and diagnosis of children with CVI. This presentation attempts to begin to address these shortfalls, by suggesting modifications to current Australian approaches, that aim to improve understanding of these children and the nature of their visual function.

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