To evaluate whether socio-economic deprivation is associated with ocular

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Purpose: To determine whether children with hyperopic refractive errors, both corrected and uncorrected, follow different patterns of everyday activity to children without any significant refractive error.

Methods: The Sydney Myopia Study (SMS) examined 2 age samples. Data from the older subgroup of 12-year old children (n=2407) after 21 randomly-selected high schools across Sydney were used. All children had a comprehensive eye examination; including cycloplegic auto-refraction (cyclopentolate 1%, Canon RK-FI). A questionnaire, completed by parents and children, provided information on daily activities, both on school days and weekends and non-school periods. Clinically significant hyperopia was defined as a spherical equivalent (SE) refraction of > 2.00 dioptres (D), using refraction of the eye with the best presenting visual acuity (VA). Children who were in contact lenses (CL) and those who had been presenting bilateral visual impairment (BVI), in the better eye 6/12 (20/40), were excluded from analyses.

Results: Clinically significant hyperopia was present in 55 children (2.4%), and of these 33.9% (n=19) wore glasses. The mean SE (SD) of children with hyperopia who wore glasses was significantly greater than among children with hyperopia who did not wear glasses (-3.44 ± 1.45 vs. -2.79 ± 0.98 respectively; p<0.001). Children with hyperopia who did not wear glasses, spent significantly less time engaging in close work (mean 19.3 hrs per week) than children with no refractive error (mean 22.6 hrs, p<0.01) and significantly less time writing per week (mean 1.7) than the emmetropic group (mean 2.9, p=0.001). Children with hyperopia who wore glasses did not significantly differ from those with no refractive error for either of these activities (near work, p=0.793; books read, p=0.7963) or in a range of other indoor and outdoor activities including playing, outdoor sport (p=0.1468) or watching TV and using computers (p=0.8561).

Conclusions: Children with uncorrected hyperopia spend significantly less time engaged in near-work than children without refractive error or those with hyperopia who were spectacles corrected. As hyperopia has previously been associated with reduced academic performance, and reading is an essential part of schooling, spectacle correction may be necessary for optimal educational outcomes in these children.

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Longitudinal Investigation of Ocular Shape Changes During Refractive Development

Purpose: To characterise changes in ocular dimensions and refractive power longitudinally as a function of refractive error.

Methods: 140 subjects (44 hyperopes (HYP), 61 emmetropes (EMM) and 35 myopes (MYO)), with an age range of 5 to 20 years participated with informed consent in the study. A spherical equivalent error (MSE) was measured for 185 subjects at baseline and 2 years later. The following measurements were obtained at baseline and 2 years later: 1. Axial length centrally and 19 degrees horizontally and vertically using partial coherence interferometry (Zeiss IOLMaster) and 2. Central and peripheral refractive power with an autokeratorefractometer (Shin-Nippon NSWsing-K 9001).

Results: Mean baseline peripheral refraction in the MYO was significantly (p<0.05) less myopic (mean difference 0.32±0.73D) than central refraction, and the axial length was significantly shorter in both the horizontal (mean difference 0.34±0.17mm, p<0.01) and vertical (mean difference 0.16±0.14mm, p<0.01) meridians. A significant (p<0.01) myopic change in central MSE of -0.48±0.50D was found in the MYO group over the two year period. This was accompanied by a significant (p<0.01) increase in central axial length of 0.26±0.23mm. Mean peripheral refraction became significantly more myopic (mean difference 0.57±0.58D, p<0.01) and mean peripheral axial length increased in both the horizontal (mean difference 0.22±0.21mm, p<0.01) and vertical (mean difference 0.25±0.21mm, p<0.01) meridians. In the HYP group peripheral refraction was significantly less hyperopic (mean difference 0.66±0.85D, p<0.01) than central refraction and the axial length was significantly shorter in both the horizontal (mean difference 0.19±0.13mm, p<0.05) in the rate of refractive development between relative peripheral myopes and relative peripheral hyperopes.

Conclusions: The prolate shape found in myopic eyes is maintained during myopic growth as similar levels of expansion occur centrally and peripherally. The more spherical eye shape found in hyperopes is maintained during eye growth. Eye shape and peripheral retinal defocus do not appear to be strong causative factors in refractive development.

CR: N.C. Strong, None; B. Cagnolati, None; L.S. Gray, None; D. Seidel, None; M. Day. None.
Support: None

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CR: N.C. Strong, None; B. Cagnolati, None; L.S. Gray, None; D. Seidel, None; M. Day. None.
Support: None

Correlation Between Refractive Error, Corneal Power and Thickness in a Large Population With a Wide Range of Ametropia
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Purpose: To determine if correlations between corneal power, pachymetry and refractive error exist throughout a large heterogeneous group of eyes with a wide range of ametropia.

Methods: Retrospective analysis of preoperative data in an excimer surgery database. 3395 eyes from 1858 subjects were included in this study. The spherical equivalent (SE) ranged from 6.75 to -44 D. Refractive error was determined by cycloplegic refraction. Ultrasound was used to measure pachymetry. Keratometry was determined using an autokeratorefractometer.

Results: When all the ametropic eyes were analyzed, the SE was observed to be inversely proportional to the mean corneal power (KM) (correlation coefficient, p-value: < -24, <0.01) and correlated directly to the corneal thickness (CT) (0.7, <0.01). The KM and CT were also inversely proportional (-10, <0.01). For just the hyperopes, a correlation between the SE and KM was also found (-25, <0.01) but the CT did not correlate with either of these metrics. For the myopes, an inverse relationship between SE and KM was observed (<8, <0.01). The KM was also found to correlate with the CT (-11, <0.01). A direct correlation was found between KM and the difference in power of the principle meridians (KD) for the ametric group. This relationship was not observed for the hyperopic group but was found in the myopic group (8, <0.01). Within the myopic group the SE also correlated with the cylinder power (-04, 0.04). In all groups, a strong correlation was observed between cylinder power and KD (average correlation coefficient: 0.78, all p-values < 0.001).

Conclusions: By observing correlations within a wide range of ametropia we have found that as the mean refractive error decreases the cornea generally steepens and becomes thinner. As the mean corneal power of myopes increases, the power difference between their principle meridians increases and corresponds to an increase in cylinder. There is a very strong relationship between the power difference in the principle meridians and cylinder refractive error. The confirmation of these relationships could help in the development of eye models and design of new corrective strategies.

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Support: None
The Relationship Between Axial Length, Refractive Error and Corneal Curvature in Children and Young Adults With Cerebral Palsy

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**Purpose:** Children and young adults with cerebral palsy (CP) have an increased incidence of high refractive errors (Schenk-Brielie et al., 1992; Sobrado et al., 1999; Kozeis et al., 2007). Whilst in the developmentally normal population there is a strong association between refractive error and axial length there are no studies examining whether this relationship holds in CP. This study is the first to investigate the relationship between refractive error and ocular biometry in 44 children and young adults with CP.

**Methods:** Measures of refractive error, axial length (AL) and corneal curvature (CC) were attempted on 44 children and young adults with CP (aged 4-19 years). Refractive error was assessed using cycloplegic retinoscopy. AL was measured with the Zeiss IOLMaster and CC with the Nidek hand-held KM 500 autokeratometer. Data from the right eye were analysed.

**Results:** Refractive error was measured successfully in all subjects. Mean spherical equivalent (MSE) ranged from -7.125D to +6.375D. AL and CC were measured in 36 (82%) and 35 (80%) subjects respectively. AL ranged from 18.94 to 27.47mm: average CC ranged from 7.28 to 8.45mm. AL was significantly correlated with MSE refractive error (r=0.91, p<0.001). CC did not significantly influence refractive error (p=-0.11, p<0.05). AL/CC ratio was calculated and compared with vascular grade, and revealed a significant relationship (r=0.92, p<0.0001), slightly strengthened by the inclusion of CC with AL data.

**Conclusions:** The relationship between refractive error and axial length in children and young adults with CP is similar to that in a developmentally normal population. Corneal power did not demonstrate an association with refractive error, again consistent with the literature. The aetiology of refractive error in CP is not due to a unique ocular biometric profile. Further investigation is required to determine whether there is a relationship between CP and high refractive errors.

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A Randomized Clinical Trial Evaluating Ready-Made Spectacles in an Adult Population in India

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**Purpose:** To compare the visual performance and acceptability of ready-made spectacles (RMS) and custom spectacles (CS) in adults with uncorrected refractive error in India.

**Methods:** A 1-month, double-masked randomized clinical trial compared RMS to CS in an untreated Indian adult population aged 18-45 years with ≥1 diopter (D) of uncorrected refractive error (URE). The primary outcome was the proportion planning to continue to use the study spectacles.

**Results:** 373 of 400 participants (93%) were enrolled and completed the study; mean age was 30±9 years and 58% were female. Average URE was 2.27±1.37D, 279/390 (72%) were myopic and habitual vision was 0.58±0.21 (logMAR). 10 participants with habitual vision better than 20/40 were excluded from the analysis (3%). The two groups were similar comparing age, sex, income, education level and overall health, with 193/200 (97%) in the RMS group and 197/200 (99%) in the CS group.

**Conclusions:** Participants prescribed RMS had significantly greater visual acuity in 90% of an adult population with URE planned to continue to use their RMS.

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The Impact of Uncorrected Presbyopia on Performance in Tasks of Daily Living and Vision-Related Quality of Life in Rural Nepal

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**Purpose:** To determine the impact of uncorrected presbyopia on the ability to perform locally relevant tasks of daily living, and on vision-related quality of life (QoL), in rural Nepal.

**Methods:** A prospective unmatched case-control study recruited 71 consecutive rural Nepali adults aged ≥45 years, and 103 chaperones, presenting to a free primary eye care clinic in Sarlahi, Nepal. After near and distance vision testing and refraction, self-reported QoL was assessed using an instrument validated in Southern India. An instrument to assess near vision-related difficulty with 15 tasks was piloted, administered, and validated using Rasch analysis.

**Results:** The mean age of cases was 53.4 years (sd 9.9y), 35 (49%) were male, and 46 (64.8%) were illiterate, whilst the mean age of controls was 28.8 years (sd 7.4y), 72 (70%) were male, and 27% (26%) were illiterate. The presenting near visual acuity was N10 or N12 in 37 (52.1%) cases, N14 or N18 in 31 (43.7%), and N24 or N36 in 3 (4.2%), and 21 cases (28%) had additional uncorrected refractive error for distance at presentation. In comparison to one control (1%), 16 (22.5%) presbyopes had modestly reduced vision-associated QoL (p<0.03), mainly affecting social and psychological domains. The mean number of controls versus 10 (7.5%) controls, reported difficulty with at least one task of daily living (p<0.0001) and, on average, cases reported difficulty with 64% of tasks previously performed. The 5 tasks most affected by near vision impairment were watching children’s activities, reading the children’s heads, recovering from skin, writing letters and reading. This instrument demonstrated good fit to the Rasch model; the mean(SD) person and item fit residual values were -0.1(2) and 0.1(0.9) respectively; there was good targeting of person ability and item difficulty; good person separation reliability (0.87), and no evidence of differential item functioning or disordered thresholds.

**Conclusions:** The Rasch-tested validated tasks of daily living instrument enabled valuable assessment of the functional impact of near vision impairment in this low literacy population. This study reveals that uncorrected presbyopia has a modest impact on vision-related quality of life and a considerable impact on the daily lives of individuals living in rural Nepal.

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Rate of Spectacle Wear and Compliance With Spectacle Wear Among Preschool Children From a Population With a High Prevalence of Astigmatism

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**Purpose:** In 1997, a research program was begun, which studied the development and treatment ofastigmatism-related amblyopia in Tohono O’odham children, who have a high prevalence ofastigmatism. We evaluated the impact of the research program by examining i) the rate of spectacle wear in preschoolers in 1997 (the start of the research program) vs. 2005 (5 years later) and ii) the rate of spectacle wear in first grade for children who were prescribed glasses when they were preschoolers in 1997 vs. 2005.

**Methods:** Subjects were preschool-aged children, recruited through the Head Start Program on the Tohono O’odham Reservation during the fall of 1997 or 2005, who were prescribed and provided with eyeglasses for high astigmatism (≥1.50 D RE or LE). Children participated in a follow-up evaluation in 1st grade (2 years later). Spectacle wear on the day of the initial and follow-up evaluations was recorded. Both cohorts received unlimited replacement eyeglasses while they were Head Start children.

**Results:** In addition, the 2nd cohort received yearly eye examinations, more frequent monitoring and replacement of spectacles, and increased teacher and parental/community education. Initial rate of spectacle wear, and the change in rate of spectacle wear from preschool to 1st grade, in the 1997 vs 2005 cohort were evaluated.

**Results:** 50 children in 1997 and 46 children in 2005 met the inclusion criteria. Mean amount of astigmatism did not differ significantly between the two cohorts in preschool or in 1st grade. The percentage of children arriving in spectacles at the initial exam was similar in the two cohorts (6.7% vs. 10.9%). Long-term (2 year) compliance from preschool to 1st grade was significantly greater than at the initial exam (p<0.001). Rate of spectacle wear was 26.7% in the 1997 cohort, which was not significantly greater than at initial exam. Long-term compliance was 47% in the 2005 cohort, which was significantly greater than at the initial exam (p<0.001).

**Conclusions:** Rate of spectacle wear in preschool children was 26.7% in the 1997 cohort, which was not significantly different than 26.7% in the 2005 cohort. Children who were prescribed and provided with eyeglasses for high astigmatism (≥1.50 D RE or LE) had significantly greater rate of spectacle wear in first grade for children who were prescribed glasses when they were preschoolers in 1997 vs. 2005.

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To study the progression of myopia in young college students to determine whether young Cornell students show a progression of myopia, and thus provide support for the hypothesis that this is driven by ocular anomalies or if measurement confounds were present, we recruited subjects for these types of studies. NY State Hatch Grant 2 provided funding for these studies. The mean age of subjects was 4.1 (0.51 SD) years at baseline, and 6.5 (0.54 SD) years at follow-up, with a range of follow-up from 2.0 to 2.7 years. Mean RA of the entire cohort did not significantly change from baseline (T1) to follow-up (T2), with only 16% of subjects having a change in refractive astigmatism of greater than 0.5 D. However, in subjects with high astigmatism, mean RA increased over time, with 25% increasing by more than 0.50 D and none decreasing by more than 0.50 D. In low astigmatism, mean RA decreased, with RA decreasing by more than 0.50 D in 10% and only increasing by less than 0.50 D in 1 subject. Similarly, mean corneal astigmatism (CA) did not significantly change for the population as a whole, but CA increased in high astigmats and decreased in low astigmats. See Table 1.

Conclusions: Consistent with other studies, we found the power of both RA and CA to be reasonably stable over time. However, in children with high astigmatism, RA and CA were likely to increase over time, whereas children with low astigmatism were less likely to have their astigmatism decrease.

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CR: D.H. Messer, None; J.M. Miller, None; V. Dobson, None; E.M. Harvey, None. Support: National Institutes of Health/National Eye Institute (NH/NEI) grants EY01535, unrestricted funds from Research to Prevent Blindness to the University of Arizona Department of Ophthalmology and Vision Science.

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CR: D.H. Messer, None; J.M. Miller, None; V. Dobson, None; E.M. Harvey, None. Support: National Institutes of Health/National Eye Institute (NH/NEI) grants EY01535, unrestricted funds from Research to Prevent Blindness to the University of Arizona Department of Ophthalmology and Vision Science.

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3973 - A84
A Randomized Controlled Trial Evaluating the Efficacy of NeuroVision’s Neural Vision Correction™ Technology in Enhancing Unaided Visual Acuity in Adults

With Low Myopia - 1 Year Follow-up Results

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Purpose: To evaluate the 1 year post treatment efficacy of NeuroVision’s Neural Vision Correction™ (NVC™) Technology in enhancing unaided visual acuity in adults with low myopia.

Methods: NeuroVision’s NVC™ technology is a non-invasive, patient-specific, perceptual learning program based on visual stimulation and facilitation of neural connections at the cortical level. It involves an internet-based computer generated visual training exercise regime using stimuli based on Gabor patches, to sharpen contrast sensitivity and visual acuity. A double masked randomized controlled trial was conducted to evaluate the efficacy of NVC™ technology in improving unaided visual acuity(UVA) of low myopic patients. 84 adult low myopic patients (LMP) with SE ≤ -0.5D were randomly divided into 2 groups. Group A (67 LMP) completed NVC™ treatment, Group B (17 LMP) completed sham treatment.

Results: Mean UVA improved by 0.18 logMar in Group A compared to 0.03 logMar in Group B (P=.042) and Group A improved more than 0.5 logMar in at least one eye compared to 11.8% in Group B (p=.0005). LMP in Group A maintained 68% of the improvement in the 12 months post treatment while LMP in Group B maintained 22%.

Conclusions: NVC™ treatment demonstrated statistically significant UVA improvement in adults with low myopia.

CR: A.Y. Fong, Singapore Eye Research Institute, F. D.T.H. Tan, Singapore Eye Research Institute, F. L.K.H. Lee, None; L. Tong, None; A. Yang, None.

Support: None; CT: www.clinicaltrials.gov, NCT00348075

3973 - A85
Myopia Progression Follow-Up in Myopic Children After Using NeuroVision’s Neural Vision Correction (NVC) Technology

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Purpose: NeuroVision’s NVC technology is a non-invasive, patient-specific, perceptual learning program based on visual stimulation and facilitation of neural connections at the cortical level, involving an internet-based computer generated visual training exercise regime using stimuli based on Gabor patches, to sharpen contrast sensitivity and visual acuity. It was demonstrated that the NVC technology is able to improve under-corrected VA and CSF in Myopic Children. We evaluated the rate of Myopia Progressing in Myopic Singaporean Children who wear habitual under-corrected spectacle prescription following a successful completion of the NVC™ treatment.

Methods: 33 children aged 7-9 having a myopia refraction of at least -1.0DS in both eyes completed NVC treatment over a period of 3-4 months. After the completion of the treatment, subjects were prescribed with habitual spectacles with highest amount of spherical under-correction that allows for VA 20/40 or better. Subjects’ Myopia progression was checked every 3 months for the first year post treatment and every 6 months for the year after.

Investigations included manifest and cycloplegic refraction and axial length measurements.

Results: 27 subjects completed 12 months follow-up. 23 subjects completed 18 months follow-up. Cycloplegic auto-refraction increased by 0.05D in the first 12 months and by 0.15D in the 6 months after. Cycloplegic subjective refraction increased by 0.50D in the first 12 months and by 0.26D in the 6 months after. Axial length increased by 0.46mm in the first 12 months and by 0.15mm in the 6 months after.

Conclusions: The Myopia progression measured in these children is less than the progression reported in similar age groups of Myopic children in Singapore. A large RCT is now underway to investigate the efficacy of this technology on Myopia progression.

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3976 - A87
Effect of a Customized Add on Near Work Induced Transient Myopia

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Purpose: A formulation has been developed by Jiang et al (2008) to determine the optimal add which would create the least error in accommodative and vergence responses. In this study we tested whether the calculated optimal add reduces near work induced transient myopia (NITM).

Methods: We measured the accommodative error and the near phoria at 40 cm under fully corrected conditions for 19 young adults. Using the formula derived previously we calculated the optimal add power for each of our 19 subjects, consisting of 10 stable myopes (SM), defined as existing myopia which has not progressed more than 0.25D over the previous 2 years, and 9 progressive myopes (PM), defined as existing myopes with at least 0.50D increase in myopia within the last 2 years. NITM was obtained by comparing their refraction as determined by a COAS aberrometer immediately before and after performing continuous basic computer work at 40cm for an hour.

This was done on two separate occasions, with and without the optimal add, in a randomized order.

Results: For SM without an add, average NITM was 0.154±0.056 (D); with the optimal add NITM was 0.027±0.109 (D). For PM without an add, average NITM was 0.212±0.062 (D); with the optimal add NITM was 0.128±0.103 (D). Comparing the overall groups by ANOVA there is a significant difference in the NITM response between SM and PM (p<.0006). For all the subjects combined there is a significant difference in the NITM response between with and without an add (p<.0024). Further analysis with Fisher’s LSD test showed a significant decrease (p<.01) in the NITM response for the SM group with an add compared to the NITM without an add. The decrease in the NITM response with and without an add for PM was not statistically significant. There was not a significant difference between the NITM response without an add when comparing the SM to the PM group. The NITM response with an add showed a significant difference for the SM group compared to the PM (p<.05).

Conclusion: With SM, application of the add derived by the formulation significantly reduces the NITM. There is a statistically non-significant trend of the calculated add reducing the NITM in PM. Further investigation on the usefulness of the add formulation and its effect on NITM is warranted.

CR: K.R. Seger, None; M. Crandall, None; L. Nani, None; B.-C. Jiang, None.

Support: HFD Grant #335249
To evaluate the efficacy, predictability and refractive stability of conductive keratoplasty for consecutive hyperopia, nine eyes of nine patients (3 male and 6 female) with high anisometropia were compared.

Methods: Ten years after LASIK, best corrected visual acuity (BCVA) improved by at least one Snellen line in 5 eyes (55.5%). No eye lost any line of BCVA. Mean preoperative spherical equivalent refraction decreased from -7.66 to -2.33 D, mean astigmatism decreased from -3.11 to -0.75 D, and mean anisotropia decreased from 7.36 to 1.47 D. Four eyes (44.4%) were within +/-1.00 D of emmetropia. All patients were able to function binocularly.

Conclusions: In this study of selected patients 8 to 15 years old, LASIK was a safe and effective option for the correction of high anisotropia and for improve binocularity, when conventional therapies had failed.

CR: B.A. Nassaralla, None; J.J. Nassaralla, Jr., None.
Support: None CT: www.clinicaltrials.gov, NCT08000774

Conductive Keratoplasty for Consecutive Hyperopia After Photorefractive Keratomileusis

To compare VA measured after removal of orthokeratology (O-K) lenses with reduced contrasts. If contrasts were especially in mesopic and glare conditions that mimic real world mesopic and glare environments.

Purpose: To compare VA measured after removal of orthokeratology (O-K) lenses compared with soft contact lens aberration controlled (CTL) or spectacle (SPC) correction of similar myopia under luminance and contrast conditions that mimic real world mesopic and glare environments.

Methods: A retrospective, noncomparative, interventional case series of patients who underwent CK for consecutive hyperopia that had been stable for at least 3 months prior to CK enhancement. The corneal zone treated by O-K lenses is limited to 6mm and combined with higher order aberrations produced poorer VA's compared with spectacle and CTL under the mesopic and glare conditions with reduced contrasts. If contrasts were sufficiently high (i.e. MC 99%) no differences were noted.

Conclusions: The VA of two groups of normal myopic eyes -0.50 to -5.50 D (<= 0.75 cyl) were compared: 1) 52 eyes having worn O-K lenses for 2 months to 2 years, measured 6 hours after removal of the lenses and 2) 151 eyes measured first with SPC and then while wearing CTL. VA was measured with the Central Vision Analyzer, an interactive computer program that presents 250msec, tumbled, Landolt C's and thresholds for the smallest C correctly discriminated (threshold 2 correct answers at the lowest opotype size, with 2 incorrect at the next lower utilizing logMAR 0.05 steps). The CVA tests 3 mesopic environments and 3 glare environments with contrasts that mimic real environments of daily living activities. For each condition mean VA and standard deviation were calculated with a two tailed, T-Test to examine significant differences between the optical corrections.

Results: A significantly worse VA was noted with O-K lenses compared with both SPC and CTL under the mesopic and glare conditions with lowered contrasts (table). The smallest C correctly discriminated was overcorrected by 1.0 diopter. Increasing post-PRK central corneal thicknesses to 20/25). Six of 9 eyes achieved a MRSE within 0.5 diopters of intended goal, one eye at 3 months was 20/25 (range 20/15 to 20/70) and at 6 months was 20/20 (range 20/20 to 20/25). Six of 9 eyes achieved a MRSE within 0.5 diopters of intended goal, one eye was overcorrected by 1.0 diopter. Increasing post-PRK central corneal thicknesses were compared: 1) 52 eyes having worn O-K lenses for 2 months to 2 years, measured 6 hours after removal of the lenses and 2) 151 eyes measured first with SPC and then while wearing CTL. VA was measured with the Central Vision Analyzer, an interactive computer program that presents 250msec, tumbled, Landolt C's and thresholds for the smallest C correctly discriminated (threshold 2 correct answers at the lowest opotype size, with 2 incorrect at the next lower utilizing logMAR 0.05 steps). The CVA tests 3 mesopic environments and 3 glare environments with contrasts that mimic real environments of daily living activities. For each condition mean VA and standard deviation were calculated with a two tailed, T-Test to examine significant differences between the optical corrections.

Conclusions: The use of conductive keratoplasty (CK) after photorefractive keratomileusis (PRK) for consecutive hyperopia is efficacious and safe, and the refractive changes are moderately stable and predictable. Further studies are needed to develop a surgical nomogram specific to corneas that have undergone ablative procedures. Long-term follow up studies are needed to determine the magnitude of regression over time.

CR: S.H. Sinclair, Vitemetrics, LLC; I. Vitemetrics, LLC; P. W. Gustein, None; R.V. North, None.
Support: None

Conductive Keratoplasty for Consecutive Hyperopia After Photorefractive Keratomileusis

To analyse post operative refractive changes in children who underwent unilateral levator resection for congenital ptosis. Both mean sphere and cylindrical change was considered for each patient and compared to changes in the fellow non operated eye which is used as an age matched control.

Methods: Details of all children who underwent unilateral levator resection performed at Maidstone Hospital, Kent between 1998 and 2001 were retrospectively analysed. Every child (4-11yrs) had congenital unilateral ptosis and underwent levator resection, performed by one oculoplastic surgeon. Cycloplegic refraction was recorded before surgery and this was compared to the final refraction performed at their last clinic visit, at least 12 months after surgery.

Results: 43 patients underwent levator resection in this 3 year time period. Complete data was collected for a total of 13 patients who underwent unilateral levator resection with a mean age of 7yrs. 61% of children had a greater refractive error on the side of the ptosis. At follow up (mean, 36.3 months; SD, 34 months), the mean spherical change in the operated eye was 0.41D (range 0.12-1.50D), compared to a mean change of 0.40D (range 0.25-2.00D) in the non operated eye. The mean cylindrical change in the operated eyes was 0.38D (range 0.25-1.00D), compared to a mean of 0.21D (range 0.50-1.75D) in the non operated eye.

Conclusions: Significant astigmatic changes following ptosis surgery has been demonstrated 1, a mechanical effect of the eyelid being suggested. Other studies have found no significant change in refraction up to 3 years post op. Whilst our final population of children was small this study did not show a significant change in refraction following levator resection surgery for congenital ptosis which had been reported in some papers. Nevertheless as the incidence of refractive is higher in those with ptosis good clinical practice would always include careful cycloplegic refraction on all children with congenital ptosis and close refractive follow up after surgical repair.


CR: S.D. Byard, None; C.A. Jones, None.
Support: None
Non-standard spectacle lenses with an optical tracking system. For this purpose, head movement patterns were analysed for radial refractive gradient (RRG) spectacle lenses with different types of radial symmetric power increase (addition). RRG spectacle lenses are of potential interest in reducing myopia progression.

Methods: Ten subjects (−0.75 D Spherical Equivalent with no optical correction or contact lenses) performed three near vision tasks (reading texts on a computer screen and on a table, handwriting) in 4 different situations: (1) wearing no lens and frame; (2) wearing a trial frame with no lenses; (3) wearing a frame with lenses with a central plano area and a radial continuous symmetric addition; (4) wearing a trial frame with lenses with a central plano area and a radial discontinuous symmetric addition. Linear and angular head movements were analysed with an optical tracking system (Optitrack®) based on the POSIT algorithm.

Results: The linear and angular resolution of the optical tracking system for head movements ranged between 1 and 2 mm and 1° and 2°, respectively. It was found that a distinct difference existed between the head movement patterns when wearing RRG lenses versus no correction. These differences increased with decreasing object distance of near vision tasks. The angular movements of the head increased up to 50% of its reference values without correction, the subjects strongly bent forward, and the head movements became more irregular during handwriting.

Conclusions: The optical tracking system provided useful data for the characterization of the wearing comfort of RRG spectacle lenses. Head movement patterns were clearly affected by the imposed peripheral defocus and distortions that were generated by this kind of lenses. These results suggest that an extensive analysis of the wearability of RRG lenses should be carried out since the head movement patterns were severely altered during near vision tasks.

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Non-cycloplegic photorefraction is used for vision screening, as part of:

Thirty seven infants were assessed longitudinally between 6 and 26 weeks, with retinal disparity but not blur cues. Correlation between cycloplegic refraction and the maximum hyperopic error was more likely to be elicited by a target size of 8.6 pixels. Aspheric lenses have high light efficiency, relatively large aperture, fast switching time, low driving voltage, and power-failure-safe configuration. These requirements have not been met simultaneously in the past.

Methods: We demonstrate new switchable, flat, thin liquid crystal lenses that satisfy the above requirements. Various characterizations of the lens is performed, including diffractive efficiencies, as a function of the lens curvature and lens location, response time, wavefront, higher-order aberration, modulation transfer function, off-axis imaging property, and chromatic aberration. A polarizing microscope is used to check the response of liquid crystal to the electrical field in a local area, and a computer interfaced, phase-shifting Mach-Zehnder interferometer is used to measure the wavefront. A setup with a multi-wavelength laser has been built to characterize the transverse chromatic aberration.

Results: Lenses with switchable powers between plano, (2) diopter, and (24) diopter have been fabricated. The lenses show high optical performance for including high diffraction efficiency (~95%), fast response time, (10μs), good spherical wavefront, small higher-order aberration, good modulation transfer function. The peak-to-valley range of the higher-order aberration is 0.24λ, and the RMS value is 0.039λ, which is comparable to a high-quality reading glass.,. The effects of the gaps between the ring electrodes and the field on the lens performance have been analyzed. The lens shows focusing powers and high optical performance for near-, intermediate-, and distance vision. Lenses with tunable power are being investigated.

Conclusions: This kind of lens is promising to become an alternative of conventional area division multi-focal spectacle lenses used by presbyopes. The new eyeglass will significantly improve the quality of life for a large population.

CR: G. Li, None.
Support: startup funding

Purpose: Presbyopia is an age-related loss of accommodation of the human eye that manifests itself as inability to shift focus from distant to near objects. More than 90% of the people over 50 need correction of presbyopia. The conventional corrective lenses (bifocal, trifocal) have been around for more than 200 years and have some drawbacks. They have a limited field of view for each vision task, requiring user to gaze down to accomplish near vision and in some cases causing dizziness and discomfort. Some users need three different eyeglasses for reading, computer, and driving. Progressive lenses cause some distortion. An electro-optic lens allows voltage controlled change of the focal power across the entire aperture and may provide a new approach to correction of presbyopia by eliminating the above limitations. Such a lens must have high light efficiency, relatively large aperture, fast switching time, low driving voltage, and power-failure-safe configuration. These requirements have not been met simultaneously in the past.

Methods: We describe a novel design of an infant keratometer that incorporates open-field, corneal viewing and on-axis illumination with a grid pattern, for study of higher-order aberrations of the eye and determination of corneal astigmatism.

Results: Infrared (940 nm) light emitting diodes in a grid array reflect off a partially (0.1%) IR-reflective mirror to illuminate the cornea. The cornea is imaged in through the first mirror and two additional IR mirrors with a telecentric lens fitted to a Sony (10%) IR-reflective mirror to illuminate the cornea. The cornea is imaged is through the above requirement. Various characterizations of the lenses is performed, including high diffractive efficiencies, as a function of the lens curvature and lens location, response time, wavefront, higher-order aberration, modulation transfer function, off-axis imaging property, and chromatic aberration. A polarizing microscope is used to check the response of liquid crystal to the electrical field in a local area, and a computer interfaced, phase-shifting Mach-Zehnder interferometer is used to measure the wavefront. A setup with a multi-wavelength laser has been built to characterize the transverse chromatic aberration.

Results: Lenses with switchable powers between plano, (2) diopter, and (24) diopter have been fabricated. The lenses show high optical performance for including high diffraction efficiency (~95%), fast response time, (10μs), good spherical wavefront, small higher-order aberration, good modulation transfer function. The peak-to-valley range of the higher-order aberration is 0.24λ, and the RMS value is 0.039λ, which is comparable to a high-quality reading glass.,. The effects of the gaps between the ring electrodes and the field on the lens performance have been analyzed. The lens shows focusing powers and high optical performance for near-, intermediate-, and distance vision. Lenses with tunable power are being investigated.

Conclusions: This kind of lens is promising to become an alternative of conventional area division multi-focal spectacle lenses used by presbyopes. The new eyeglass will significantly improve the quality of life for a large population.

CR: G. Li, None.
Support: startup funding

Purpose: Fluidic spherical and cylindrical lenses have high light efficiency, relatively large aperture, fast switching time, low driving voltage, and power-failure-safe configuration. These requirements have not been met simultaneously in the past. Fluidic spherical and cylindrical lenses can be fabricated using this method by changing the shape of the aperture in the aluminum holder. The radii of curvature of the deformed membrane was measured with interferometry to determine the change in lens power as a function of fluid volume.

Results: Spherical powers from -2.50 to 2.50 D in 0.2 D steps were achieved with our prototype. The change in power as a function of fluid volume is highly linear (r2=0.99). Cylindrical powers from -3 dioptrers to +3 dioptrers were similarly achieved and have the same linear response. There is some induction of cylindrical power in the orthogonal direction with these lenses. The rate of induction was 0.17 D in the orthogonal direction for every 1 D in the desired direction. Higher order aberrations with these lenses remained small.

Conclusions: Fluidic lenses have the potential to create variable levels of sphercial and cylindrical power. We envision a series of three lenses being used in a refractometer. The device would consist of a spherical lens and two cylindrical lenses rotated 45 degrees to one another. This configuration and wide range of sphero-cylindrical corrections could be achieved, including cylinder axis variations.

CR: R. Marks, None; D. Mathine, None; G. Peyman, None; N. Peyghambarnia, None; J. Schwiegerling, None.
Support: None

Purpose: We describe a novel design of an infant keratometer that incorporates open-field, corneal viewing and on-axis illumination with a grid pattern, for study of higher-order aberrations of the eye and determination of corneal astigmatism.

Methods: Infrared (940 nm) light emitting diodes in a grid array reflect off a partially (0.1%) IR-reflective mirror to illuminate the cornea. The cornea is imaged through the first mirror and two additional IR mirrors with a telecentric lens fitted to a Sony (10%) IR-reflective mirror to illuminate the cornea. The cornea is imaged is through the above requirement. Various characterizations of the lenses is performed, including high diffractive efficiencies, as a function of the lens curvature and lens location, response time, wavefront, higher-order aberration, modulation transfer function, off-axis imaging property, and chromatic aberration. A polarizing microscope is used to check the response of liquid crystal to the electrical field in a local area, and a computer interfaced, phase-shifting Mach-Zehnder interferometer is used to measure the wavefront. A setup with a multi-wavelength laser has been built to characterize the transverse chromatic aberration.

Results: Lenses with switchable powers between plano, (2) diopter, and (24) diopter have been fabricated. The lenses show high optical performance for including high diffraction efficiency (~95%), fast response time, (10μs), good spherical wavefront, small higher-order aberration, good modulation transfer function. The peak-to-valley range of the higher-order aberration is 0.24λ, and the RMS value is 0.039λ, which is comparable to a high-quality reading glass.,. The effects of the gaps between the ring electrodes and the field on the lens performance have been analyzed. The lens shows focusing powers and high optical performance for near-, intermediate-, and distance vision. Lenses with tunable power are being investigated.

Conclusions: This kind of lens is promising to become an alternative of conventional area division multi-focal spectacle lenses used by presbyopes. The new eyeglass will significantly improve the quality of life for a large population.

CR: G. Li, None.
Support: startup funding

Purpose: Optimum stimulus characteristics for eliciting maximum hyperopic refractive error in non-cycloplegic photorefraction.

Methods: Non-cycloplegic photorefraction is used for vision screening, as part of optometric examination and experimentally when assessing accommodation responses. This study investigated which target condition would elicit maximum manifest hyperopic refractive error in infants, children, and adults.

Results: The maximum hyperopic error was more likely to be elicited by a target moving away from the participant at all ages. Stimuli that contained disparity and/or size change cues were more likely to produce maximum hyperopic error than targets containing blur cues. Correlation between cycloplegic refraction and the maximum hyperopic refraction obtained from non-cycloplegic photorefraction was high (r = 0.88, p<0.0001), and there was no significant difference between these measures (t=0.93, p=0.3; ns; 95% confidence limits ±1.75D).

Conclusions: The size change cue, as a target moves into the distance, along with retinal disparity but not blur cues, appears to be most effective in relaxing accommodation. Previous studies have shown that disparity is the main cue to accommodation in adults. In the same study we also found that looming was a very weak cue to vergence and accommodation in adults. However, these findings seem to suggest that reduction in target size, as the target moves away, might assist in relaxation of accommodation providing an estimate of manifest hyperopic refractive error, at least in the population tested here.

CR: P.M. Riddell, None; J. Schwiegerling, None.
Support: DOH fellowship FWA 01/05/03 to AMH
Comparison of the PediaVision Vision Screener to the Nikon Retinomax in a Population of School Aged Children With Intellectual Disability


**Purpose:** The purpose of the study was to compare the PediaVision to the Nikon Retinomax in a population of school aged children with intellectual or developmental disabilities (ID) in a screening setting.

**Method:** The Nikon Retinomax is the standard autorefractor used in the Special Olympics Lions Clubs International Opening Eyes Vision Program. It has been shown to be valid and reliable in the hands of non-eye care providers. PediaVision is a new screening tool for refractive error and abnormal eye posture. It was compared to the Retinomax on both testability and correlation of spherical equivalent of the right eye.

**Results:** 140 subjects from the Chicago Public Schools presented to be screened. The screening included a comprehensive battery of tests which included autorefractive. Nikon Retinomax was administered first then the PediaVision rather than in a random presentation. 108 subjects completed both tests, 4 subjects were untestable on both instruments. Of the remaining subjects, 4 were able to be tested on either the Retinomax or the PediaVision and 2 athletes were testable on only one eye or all but one eye. Paired tests sample of spherical equivalent in the OD was 0.637 p<.000. Bland-Altman plot of comparing the techniques will show the moderate correlation with the PediaVision reading more hyperopic or less myopic than the Nikon Retinomax.

**Conclusion:** The PediaVision was not as testable as the Nikon Retinomax with subjects ID. The setting was noisy and subjects presented with complex vision findings (strabismus and strabismus). In addition, it was always the second of the two instruments. For autorefracraction on site, the PediaVision showed moderate correlation to the Retinomax. If further analysis the PediaVision is valid for screening for astigmatism it may be a preferred tool in large scale screening of children and adults with ID by laypersons.

CR: S.S. Block, None; K. Harris, None; J.L.H. Harris, None; J. O’Brien, None; A.J. Ottaviano, None. Support: Support was provided by PediaVision

Accuracy Assessment of Autorefractometer and Wavefront Aberrometer Refraction in a Large Population


**Purpose:** The study objective was to evaluate the accuracy of an automated refractionometer and a wavefront aberrometer in predicting subjective refraction findings.

**Methods:** Refraction was measured in 180 eyes of young adult subjects aged between 18 and 45 using an autorefractometer (Canon 1000, Canon, Japan) and a wavefront aberrometer (irx3, Imagine Eyes, France). Besides, the subjects’ subjective refractions were evaluated using trial lenses and a Bailey Lovie chart, following a preliminary retinoscopy examination. The objective automated refraction findings were expressed in the form of power vectors (M, J45 and J180) and compared with subjective measurements, used as reference values. In the case of wavefront outcomes, two different metrics were used to calculate spherocylindrical refractions: one was based on second-order Zernike coefficients only while the other took into account high-order aberrations. The results were analyzed using linear regression and displayed in the form of Bland-Altman plots.

**Results:** High correlations (R²>0.85, p<0.01) were found when comparing objective versus subjective findings. The correlations were similar for the autorefractometer and the wavefront aberrometer. For the wavefront method, higher accuracy and precision were found when high-order aberrations were taken into account.

**Conclusions:** Objective refraction measurements were able to predict subjective findings with a precision better than half of a diopter.

CR: J.-L.D. Nguyen-Khoa, None; P. Hernández, None; V. Fernández, None; N. Lopez-Gil, None. Support: None

The Ideal Pinhole

M.T. Whitney, P. O’Connor. Ophthalmology, UT Health Science Center, San Antonio, TX.

**Purpose:** To determine the ideal pinhole size for measuring the best uncorrected visual acuity and to delineate the limitations of the pinhole occluder.

**Methods:** The cohort was composed of 13 subjects between the ages of 28 and 65 with corrected visual acuity (CVA) less than 20/20. The coregistration of automated retinoscopy and corrected refraction of 20/20 or better. Eleven subjects were myopic, one was hyperopic and one was emmetropic. Refractive errors were recorded and vision checked with and without correction in each eye using a Snellen projection chart at 20 feet, with an illumination of 13 foot-candles of light at the screen. Multiple pinhole discs of varied aperture sizes (0.5, 0.75, 1.0, 1.2, 1.5 mm) were used to document the best pinhole vision for each disc in the corrected and uncorrected state.

**Results:** Measured visual acuities were converted to LogMAR equivalents for statistical analysis. The mean uncorrected visual acuity was 0.08 (range 0.02 to 1.7). The mean refractive error was -4 diopters (range -11 to +0.25 diopters). Mean visual acuities obtained for each pinhole aperture of 0.5, 0.75, 1.0, 1.2, and 1.5mm were 0.28, 0.31, 1.0, 0.4, and 0.5 LogMAR equivalents, respectively.

**Conclusions:** Clinically, multiple pinhole occluders with a 1.2 mm aperture are used during routine Ophthalmologic examination to benchmark the potential for best refractive visual correction. We found this device allows subjects to see 0.17 LogMAR (20/30 Snellen equivalent) with a refractive error up to 3.5 diopters and 1.16 LogMAR (20/300 Snellen equivalent) with 7 to 11 diopters limiting its usefulness in subjects with higher refractive errors. Our study also suggests that despite decreased illumination and increased diffraction, smaller multiple pinhole discs better predict best corrected visual acuity in subjects with high refractive errors. Of note, the best uncorrected visual acuity for high myopes using the 0.5mm multiple pinhole was no better than 0.3 LogMAR (20/40 Snellen equivalent), clearly demonstrating the limitations of the pinhole in achieving the best uncorrected visual acuity. In addition smaller aperture multiple pinhole discs (especially 0.5 and 0.75) yield a decrease in best corrected vision in fully corrected ametropes and emmetropes due to defractive effects. These findings suggest there is no one ideal multiple pinhole disc for every possible situation.

CR: M.T. Whitney, None; P. O’Connor, None. Support: None

Rapid Measurement of Longitudinal Chromatic Aberration With Automated Polychromatic Photorefractometry

F. Schaeffel, K. Haymak, U. Mester. ‘Section Neurobiology of the Eye, Centre for Ophthalmology, Tubingen, Germany; ‘Department of Ophthalmology, Bundeskassnchafts’s Hospital, Sulzbach, Germany.

**Purpose:** To develop and test a white light photorefractor for measuring longitudinal chromatic aberration.

**Methods:** While eccentric photorefractometry was automated for infrared light and used for high myopes, the automated photorefractometry was not further explored. We used a USB2 RGB camera and software developed in Visual C++ by FS to record simultaneously the brightness profiles in the pupil for the Red (R), Green (G) and Blue (B) channels, using a USB-controlled bright flash of white LEDs in an eccentric retinoscope. R sampled at around 620 nm, G at 540 nm, and B at 470 nm. Six emmetropic student subjects were individually calibrated with trial lenses in R and G and B.

**Results:** A major obstacle was the low reflectivity of the fundus in the blue, despite that the white LEDs had an emission peak at 470 nm. The RGB channels of the camera had to be individually adjusted to provide similar brightness of the photoretinoscopic reflex in the pupil. After this, the factors converting the steepness of the brightness slopes in the pupil into refraction became similar. Surprisingly, the refractions in the three wavelength bands were undistinguishable (average refractions B 0.36D, G 0.29D, R 0.36D) even though the average standard deviations were small (B 0.20D, G 0.29D, R 0.36D). Since measurement noise cannot explain the lack of a change in the refractions with wavelengths, a confounding factor is expected. A possible candidate is the variable penetration depth of light of different wavelengths into the fundal layers. Red light may penetrate deeper, causing an apparently longer (more myopic) eye - which could balance the effects of longitudinal chromatic aberration. To match published chromatic aberration curves, refractions in the blue had to be made 1.05x more myopic than measured and 0.50D in the green when red was taken as baseline. Using this assumption, red light would be reflected from layers about 0.39 mm deeper in the fundus, than green (0.19 mm), and blue (0 nm).

**Conclusions:** After matching the brightness of the RGB channels of the camera and correcting for the variations in the penetration of light of different wavelengths into the fundus, this technique may be a fast and convenient way to measure longitudinal chromatic aberration from a distance in normal subjects and pseudophakic patients.

CR: F. Schaeffel, None; K. Haymak, None; U. Mester, None. Support: None
Comparison of Letter versus Laser Targets on Measuring Central and Peripheral Autorefraction

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Purpose: It is known that target types can influence the outcome of refractive measurements due to such effects as accommodative effort, chromatic aberration and depth of focus. We studied the effect of using letter versus laser targets during autorefraction measurement of both central and peripheral refraction.

Methods: As part of a larger study to investigate relative peripheral refraction and accommodation, both eyes of five young subjects (age 23 to 28 years, refractive error +0.50D to -0.75D) were measured with a modified Shin-Nippon NVision K5001 open-field autorefractor (Shin-Nippon, Tokyo, Japan). The subjects were asked to fixate on high contrast standard letter E (6/12 or 20/40) targets and red (650-680 nm) diode laser elliptical spots (3.75 mm spot width) at a viewing distance of 2.5 m. Each subject was measured at 0°, 20°, 30° and 40° eccentricities both nasally and temporally. Each measurement was repeated three times. From the refractive data, mean sphere (M) and cylinder/astigmatism (C) were analysed and compared using Bland-Altman analyses.

Results: Average intra-session repeatability (standard deviation) for both target types was ±0.35D. The mean difference and standard deviation in M between the two measurement methods (laser target - letter target) for all measured eccentricities for right and left eyes were 0.03D ± 0.23D and 0.06D ± 0.25D respectively. The mean difference and standard deviation in C for right and left eyes were -0.06D ± 0.42D and -0.06D ± 0.24D respectively.

Conclusions: The results suggest no systematic difference between target types and measured refraction. Variability of results tended to increase with eccentricity suggesting differences between target types may be due to other factors (e.g. precision of alignment of eye).

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