Advancing Education in Optometry

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1 Study of stereo-acuity norms in Taiwan teenager and their relation to 3D display
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Purpose: One factor in the evaluation of binocular vision is the measurement of stereo-acuity (SA). The purpose of the study was to establish SA norms in Taiwan teenagers. It is important to collect normative data, which can be applied in clinical settings. Among the many display technologies, stereoscopic displays are the most popular. We want to know if these 3D display products are appropriate for the people in Taiwan.

Methods: The Randot stereo test was used to test SA for 103 normal participators (51 males and 52 females) aged between fifteen and eighteen. External examination, cover test, accommodation amplitude, phoria, visual acuity and non-cycloplegic auto-refraction were assessed for each subject prior to Randot stereo test. With tests, their eyes did not appear to have major diseases or injuries and all refractive errors were corrected with spectacle lenses or contact lenses.

Results: The range of SA at 40 cm was 20 to 400 seconds of arc. The mean SA for the teenagers was about 63.62±5.08 seconds of arc. The PD was about 59.43±2.18 mm and the visual acuity was about 20/25. The results possibly represent that the 3D products in the market do not fit Taiwanese teenagers because they were not designed for them.

Discussion: People will feel uncomfortable if 3D display were not designed with their visual characteristics. Therefore, it is not only necessary to consider the factors of binocular disparity, depth, and accommodation while designing the 3D images, but also to remind users with different visual needs for possible discomforts. In future, we will set conditions of binocular disparity, convergence, and depth of focus for Taiwanese teenagers and will attempt to establish a 3D display standard in order to help people to enjoy 3D movies comfortably.

2 The effects of vision therapy on elementary school children with binocular dysfunctions
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Purpose: The purpose of this study is to examine the effectiveness of vision therapy applied to elementary school children with binocular dysfunctions.

Method: The subjects for the experiment were selected out of 1,123 pupils (aged 8-13) at an elementary school in G city in the Gyeongnam Province of Korea. The selection was based on the COVD-QOL surveys targeting pupils and their parents and the examinations for visual symptoms. The pre-experimental COVD-QOL survey showed that 188 children complained of eye symptoms. 123 of the children were tested for binocular function. Following the test results, 38 subjects with binocular dysfunctions were divided into an experimental group and a control group, respectively. Experimental groups underwent vision therapy for 12 weeks.

Results: The results of the comparison are the following:
1) In COVD-QOL survey, all school year children except for those in first year showed significantly higher average scores than their parents' responses (p<0.05).
2) Children scoring 20 or more in COVD-QOL survey, who require close clinical inspection by an expert, appeared at rates of 17.25% and 11.74% in the children's and parents' surveys, respectively.
3) The COVID-QOL scores vs. the academic scores of the subjects appeared to correlate negatively (p<0.05).
4) Out of the 123 children who complained of eye symptoms, 93 (75.61%) appeared to have binocular dysfunctions.
5) Children with vergence dysfunctions or accommodative dysfunctions appeared to be significantly lower in academic scores than the control group (p<0.05).
6) The vision therapy conducted alleviated the symptoms of the subjects with accommodative dysfunctions or vergence dysfunctions or both.
7) The vision therapy conducted significantly improved the near point of convergence, positive fusional vergence, monocular accommodative facility, and the binocular accommodative facility of the subjects with accommodative dysfunctions or vergence dysfunctions or both.

Conclusion: Through these results, vision therapy is verified to be an effective treatment in alleviating the symptoms of the children with binocular dysfunctions.

3 Association of visual function and academic learning
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Purpose: To investigate the correlation between vision, especially binocular function, and academic learning in the elementary school children in Taiwan.

Methods: 222 healthy 6th Grade students participated in the study. Ocular examination included visual acuity determination, cover test, maximal plus subjective refraction for best vision, modified Thorington test, and assessment of saccade, ocular motility, NPC, NPA, stereopsis, and accommodative facility. Additionally, students and their parents were asked to complete a questionnaire on ocular and physical responses when performing distance and near visual tasks. This was supplemented by the students’ scholastic achievement and IQ scores, both of which transcribed from school records with parental consent.

Results: First, uncorrected and under-corrected students complained of wry neck, squinting to see, sleepiness, ocular pain and tearing (r= -0.172~ -0.393, p=.000 ~ .048) while performing distance visual tasks. Students who had abnormal visual functions, such as refractive error, ocular posture, saccade, NPC, NPA, and accommodative facility, experienced easy fatigue (r= -0.250 ~ -0.168, p=.003 ~ .045), squinting (r= -0.212 ~-0.089, p=.011~.046), and needing more time to finish homework assignment (r= -0.223 ~ -.168, p=.008 ~ .047). Further, statistically significant correlation was noted between the degree of difficulty in learning Mandarin Chinese and the results from both cover test (r=-.346, p=.002) and NPC recovery point measurement (r=-.241, p=.036), and also that between learning of English language and NPC recovery point (r=-.248, p=.031). In contrast, binocular visual functions did not correlate with the learning of mathematics.

Discussion: Our study showed a close correlation between visual function and academic learning. Parents, educators, and medical personnel should realize the importance of this correlation, so that when the students exhibit learning-interfering visual symptoms, early remedial intervention can be readily instituted.

4 A case report of patient with learning disability treated with optometric vision therapy and training
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Presenting signs and symptoms: A 6 years old Asian female was referred to us with complaints of poor vision, poor eye hand coordination, inability to read properly (skipped words and lines), inability to concentrate, reversed letters and numbers, poor hand writing, poor directionality and laterality, problems in copying from the board, inability to remember things. She was born full term through C section to a healthy mother. She suffered from asphyxia after birth during feeding, which was controlled immediately. Her milestones were delayed and had been undergoing speech therapy and special education. She has 2 healthy siblings.

Objective measurements: She was found to have a small refractive error, which was corrected. She was found to have poor and ill sustained fixation, poor ocular motility with poor correct percentile and slow response time in pursuits and saccades and poor accommodative facility. She was suppressing her left eye and had poor fusional ranges. Non motor TVPS analysis showed insufficient visual perceptual skills.

Assessment: She was found to have non strabismic binocular vision disorders and visual perceptual disorders.

Case management plan: She was given Vision therapy comprising of anti-suppression, accommodation and vergence therapies. Initially she was on Brock string to initiate fusion. It was achieved after a few sessions and she attained stereopsis too. She was provided visual perceptual therapy too. After 20 sessions of therapy her parameters improved considerably with normalized accommodative facility, pursuits and saccades. Her fusional ranges have improved and she does not suppress anymore. In academics too, her performance has improved considerably with improved concentration, reading abilities, highly improved hand writing and directionality.

Discussion: Optometric vision therapy and visual perceptual therapy aid in providing treatment in cases of learning disability, which are generally ignored due to poor awareness of these therapies among optometrists.

Ocular manifestations in children with developmental delay
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Purpose: Many studies have shown a higher incidence of refractive error in children with developmental delay ranging from 27.3% to 58.5%. The purpose of the present research was to study the ocular manifestations in children with developmental delay.

Methods: A cross–sectional study was conducted at a multispecialty camp. Children with global developmental delay, motor delay, seizure, downs and other syndromes were included. All subjects underwent a complete eye examination including distance visual acuity on Lea symbol chart, muscle balance, anterior and posterior segment evaluation, Intra Ocular Pressure (IOP) by rebound tonometer and refraction with homatropine.

Results: Total of 181 subjects, (mean age of 8.17 ± 5.81 years) including 107 males and 74 females were studied. The mean visual acuity was 0.31 ± 0.24 Log MAR (54 subjects). Refractive error was found in 75.97%, where 29.56% had myopia, 25.42% had hyperopia and 20.99% had astigmatism. The mean IOP in the right and left eye was 14.18 ± 3.49 and 14.27 ± 3.84 mmHg respectively. Cataract was observed in 7 eyes (1.93%), micro cornea, corneal opacity and bitot spots in 4 eyes each (1.10%). Nystagmus was observed in 12 subjects (6.63%). Retinitis pigmentosa was seen in 6 eyes (1.66%), tessellated fundus and temporal crescent in 2 eyes each (0.55%). Eso-deviation was seen in 24 subjects (13.26%) and exo-deviation in 20 subjects (11.05%). Cortical visual impairment was diagnosed
in 19 subjects (10.50%). Glasses were prescribed to 75 subjects (41.67%), patching was advised to 18
subjects (10%), surgery to 4 subjects (2.22%), medications to 7 subjects (3.89%), VEP and referral to
blind school to 2 subjects each (2.11%).

Conclusion: Refractive error was a common ocular manifestation (75.97%) observed in patients with
developmental delay and was found to be higher in the present study population when compared with
other studies globally.

6

QEEG differences of visual attention processing in children with developmental
dyslexia
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Purpose: This study investigates the reaction time and accuracy to use cue-target process (Posner,
1990) for dyslexic and normal children, the differences of brain wave to utilize an electroencephalogram
at P100, visual process early response, and after P300.

Methods: 10 children with development dyslexia and 18 normal children participated in this experiment.
Subjects were selected from elementary schools in Il-san area. All had corrected eyesight 0.3 over and
IQ 85 over. Selection criteria for dyslexia were K-LDES spelling measure 15 point over, for IQ test we
used K-WISC IV. Stimuli were designed with E-prime 1.0. P100 and P300 QEEG were measured with
64 channels Quick-cap and ERP data were analyzed using scan 4.x. To investigate differences
between the two groups, we performed non-parametric Mann-Whitney U using SPSS 18 ver.

Results: Analysis revealed significant differences in the mean RT between developmental dyslexia and
normal (Z=-2.829, p=0.004); however, no differences were found in the accuracy between two groups
(Z=-1.632, P=0.106). Grand average ERPs at P100 and P300 between development dyslexia and
normal group are shown at P5 and P6 of temporal-parietal lobe. While there were no significant
differences in left hemisphere between two groups, there were significant differences in right
hemisphere (P5: Z=-1.630, p=0.109, P6: Z=-2.877, P=0.003).

Discussion: During the visual attention processing, the responses of the children with developmental
dyslexia were late, however, no difference as contrasted with normal children in the accuracy. To
conclude, the defect of left hemisphere system obstructed automatically stimulated perception, whereas
it seemed that the compensated system worked toward the right hemisphere, but slow in some degree
in accuracy reading with developmental dyslexia.

7

The role of ocular movement in reading
James I-Chih Chan, Kuo-Chen Su, Ching-Chung Chen, Shu-Chen Hsu, Shun-Chan Chang, Chun-
Yen Wang, Yeh-Wei Tsai, Shyan-Tang Chen, Hong-Ming Cheng, Ching-Ying Cheng
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Purpose: To analyze ocular movement involved in reading and investigates the correlation between
this movement and binocular visual function in elementary school students.

Methods: 622 healthy 3rd to 6th Grade elementary school students participated in the study. Data of
the reading eye movement including the number of fixation and regression per 100 words, the fixation
duration (in secs), and the reading rates (in words/min) were recorded with the ReadAlyzer (Compevo
AB, Stockholm, Sweden) and further analyzed. Binocular functions such as saccade, NPC and NPA were also conducted within the same examination session.

**Results:** Only 75 students (12.06% of total) had passed the screening criteria that included reading comprehension. With the increasing age, the number of fixation/100 words decreased from 3rd to 6th Grades at 112.64, 116.68, 90.47, and 76.68, respectively. The number of regression/100 words also decreased from 3rd to 6th Grades at 28.79, 25.26, 20, and 15.32, respectively. So did the fixation duration changing from 3rd to 6th Grades at 0.4114, 0.3047, 0.2906, and 0.3060 sec, respectively. At the same time, the reading rate increased from 3rd to 6th Grades at 181.86, 223.84, 271.53, and 291.52, respectively. In addition, these reading eye movement parameters were significantly correlated with binocular horizontal movements, such as saccade \((r=0.376~0.446, p=0.013~0.037)\), NPC break and recovery \((r=0.496~0.648, p=0.006~0.036)\), and NPA \((r=-0.345~0.436, p=0.031~0.045)\). The data were also compared with English reading, and significant difference was noted in fixation \((t=-2.761~7.265, p=0.000~0.016)\), regression \((t=-2.962~4.988, p=0.000~0.009)\), fixation duration \((t=3.49~3.565, p=0.002~0.003)\), and the reading rate \((t=3.537~5.131, p=0.000~0.003)\).

**Conclusions:** Our study represents the first using the ReadAlyzer to investigate the role of ocular movement in reading and also the first to report the correlation between reading ocular movement and binocular visual function. Our results further indicate that reading the pictogrammatic Mandarin Chinese is significantly different from reading the alphabet-based English.

**8**

The effect of coloured overlays on reading speed in university students

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**Purpose:** To compare the reading speed of university students when reading through coloured overlays, no overlay and a gray overlay.

**Methods:** Participants were 30 university students (mean age, 22.1 ± 2.3 years), with normal ocular health, binocular visual function, visual acuity (better than 6/6 Snellen VA) and level of visual stress as tested using pattern glare test. Each participant was given a choice of preferred coloured overlay for reading out of 12 coloured overlays. The reading rate of participants was assessed using the Wilkins Rate of Reading Test (Korean Language) under three conditions: with their chosen coloured overlay (condition 1), with gray overlay to simulate a reduction in luminance contrast only (condition 2) and without overlay (condition 3). The order of conditions was pseudo-randomized to minimize the effects of learning and fatigue.

**Results:** Overall, the rate of reading was significantly higher in condition 1 (133.4 ± 11.5 words) than conditions 2 (110.5 ± 9.5) and 3 (113 ± 8.7) \((p<0.05)\). There was no difference in reading rate between conditions 2 and 3.

**Conclusion:** The introduction of colour contrast through coloured overlays increases reading rate whereas a reduction of luminance contrast does not affect reading rate in university students with normal binocular vision.

**9**

Correlation between after-school learning and myopic progression of elementary school students in Taiwan

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**Purpose:** To investigate correlation between after-school learning and myopic progression in the elementary school students in Taiwan.

**Methods:** 1,067 students aged from 7 to 12 years with no ocular or systemic diseases participated in the study. Ocular examination included uncorrected visual acuity measurement, autorefraction, and subjective refraction to obtain the best corrected vision. In addition, students and their parents were asked to fill out a questionnaire on the students’ learning environment, study subjects, and habitual visual use during after-school hours.

**Results:** A change of refractive errors was noted, from OD: -0.1447D, OS: -0.1332 in the first grade to OD: -1.5832D, OS: -1.5899 in the 6th grade. Plus a sudden increase in myopia between Grades 1 and 2 (OD: t = 2.195, p = 0.029; OS: t = 2.308, p = 0.022), Grades 2 and 3 (OD: t = 2.254, p = 0.025; OS: t = 2.171, p = 0.031), and also between Grades 5 and 6 (OD: t = 2.418, p = 0.016; OS: t = 2.094, p = 0.037). Myopic progression was significantly correlated with the students’ after-school environment, placement, and the time of the parents’ accompanying the students. In addition, myopic progression was significantly correlated with the learning of English as a foreign language, abacus operation, and mental arithmetic, and also outdoor activities.

**Discussion:** Our results indicate that myopic progression is significantly correlated with after-school learning environment, after-school learning subjects, and outdoor activities. Given that these activities are often chosen by the parents, they have played a main role in the developmental stage of the students, and unwittingly, also when the latter are most susceptible to myopization.

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**Corneal indices in Down's syndrome**

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Lotus College of Optometry, Mumbai, India

**Purpose:** Corneal changes are reported in patients diagnosed with Down’s syndrome. This research was done to study the corneal topography and endothelial changes in patients with Down’s syndrome.

**Methods:** A cross-sectional study was conducted at the tertiary eye care center. Patients diagnosed with Down’s syndrome with or without mental retardation were studied. Informed consent was obtained from parents and school authorities for all the subjects. Each subject underwent a complete ocular examination including visual acuity in LogMAR, objective and subjective refraction. Corneal indices were assessed by topographer (TMS-4) and specular microscopy (SP.3000p).

**Results:** 49 Down’s subjects (22 males and 27 females) with a mean age of 19.3 ± 8.21 years were included. The mean flat, steep and average topographic value were 45.64D ± 1.98D, 47.43D ± 0.09D and 46.50D ± 2.05D respectively. The mean corneal cylinder was -1.85D ± 0.16D. On keratoconus screening by Klyce / Maeda (KCI) and Smolek / Klyce (KSI) statistics, 6 eyes were diagnosed with keratoconus and 8 eyes were suspects. On non-contact pachymetry, the mean corneal thickness observed was 0.495 ± 0.04mm. On specular microscopy, the mean minimum and maximum cell sizes were 149.85 ± 160.62 µm² and 737.52 ± 167.62 µm² respectively, the mean density of cells and mean hexagonally were 2816.94 ± 395.72/mm² and 58.37± 15.15% respectively.

**Discussion:** About 6.12 % subjects with Down’s syndrome have an incidence for developing keratoconus. Corneal endothelial cell changes are also a common feature seen in these subjects. The non-contact diagnostic tests topography and specular microscopy proved to be useful diagnostic tools in evaluation of Down’s subjects.
Accommodative lag in young myopes with multifocal soft contact lenses

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Purpose: Some studies have shown decreased accommodative lag responsible helping to arrest increase in myopia, but there are still controversies over whether accommodative lag has an effect on myopic progression. This research was done to study the effects of multifocal soft contact lenses on accommodative lag in myopes.

Methods: Subjects aged 18–25 years with refractive error between -1.00 to -5.50D, visual acuity of 0.0 logMAR for distance and 0.63M for near, astigmatism and anisometropia ≤ 0.75D, stereo acuity of 40 sec of arc, and without any ocular abnormalities were included. Informed consent was obtained from all the subjects. In phase one normative data of accommodative lag was obtained for the WAM5500 using WCS-1 (high speed mode). In phase two (interventional phase) accommodative lag was assessed using center near soft lens multifocal design with low add.

Results: Phase one included 29 subjects (mean age 20.34 ± 1.96 years) with mean refractive error of -3.00D ± 1.07D and -2.97 ± 1.71D in right and left eye respectively. The mean accommodative lag in the right and left eye was 0.62D ± 0.33D and 0.55D ± 0.42D respectively. Phase two included 16 subjects (mean age 20.62 ± 2.55 years) with mean refractive error of -2.44D ± 1.07D and -2.27 ± 1.17D in right and left eye respectively. The mean accommodative lag in the right eye (+0.55D ± 0.19D) and left eye (+0.58 ± 0.20D) increased to +0.81 ± 0.17D and +0.83D ±0.23D respectively with the use of contact lenses, showing a statistical significant difference (p<0.05). Statistical significant difference was observed in the mean accommodative lag between subjects in phase one and phase two (p<0.05).

Discussion: Center near multifocal soft contact lenses is found to increase the accommodative lag in myopic subjects. Longitudinal studies are indicated to study the effect of these lenses on myopic progression.

Characteristics of refractive error as a function of age in a Korean population

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Purpose: To characterize refractive errors as a function of age in a Korean clinical population.

Methods: All records of 884 patients to visit KE optical shop in the year 2007–2010 were used for the study. Subjects were divided into six age groups by decade (10s, 20s, 30s, 40s, 50s, and 60s). Refractive errors were decomposed into spherical-equivalent refractive error (M), (myopia, M≤ -0.75; hyperopia, M≥ +0.75). Astigmatic groups were categorized by the cyl ≥-1.00 and were classified by the with-the-rule (WTR), against-the-rule (ATR), and oblique astigmatism. From the corneal power, keratometric readings, and corneal astigmatism measured by Potec PRK-5000, internal astigmatism was calculated by subtracting corneal astigmatism (CA) from refractive astigmatism (RA) and J0 and J45 astigmatic components were analyzed. Statistical analysis was performed with the SPSS/win programs (version 18.0; SPSS, Inc.).

Results: Of the subjects 88.6% had myopia and 2.7% had hyperopia and 45.2% had astigmatism. The mean value of the age decade was 10s; -4.11±2.54D, 20s; -4.47±2.86D, 30s; -3.89±2.67D, 40s; -3.37±2.46D, 50s; -2.27±3.01D, 60s; -0.60±2.25D, the subjects progressively shifts from myopia to hyperopia with age. The prevalence of WTR astigmatism is 63.1% and ATR astigmatism is 11.1% and
oblique astigmatism is 25.8%. And WTR astigmatism was highly dominant in teen age group, while 45.8% of the 60s were ATR astigmatism. J0 RA was 10s; +0.60±0.47D, 20s; +0.47±0.48D, 30s; +0.36±0.46D, 40s; +0.23±0.49D, 50s; +0.15±0.45D, 60s; +0.01±0.50D, and J0 CA was +0.79±0.42D for 10s, +0.71±0.44D for 20s, +0.54±0.45D for 30s, +0.39±0.44D for 40s, +0.29±0.44D for 50s, +0.10±0.44D for 60s. J0 RA was strongly correlated with CA (R2=0.61).

Conclusions: A prevalence rates of both myopia and WTR astigmatism is increased during the first decades and majority of the elderly (over 60s) had hyperopia and ATR astigmatism. Both refractive and corneal J0 components seem to decrease with aging, supporting the hypothesis that the shift from WTR to ATR manifests astigmatism being dominated by a corneal change.

13 Refractive errors in the Maldives – a pilot study
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Purpose: The aim of the study was to determine the pattern of refractive errors in the Maldivian population

Methods: Visual acuity assessment, automated refraction followed by retinoscopy, and subjective refraction, along with the anterior and posterior segment examination was done in 1917 cases who visited the Eye Care clinic for the first time, from July 01 to Dec 31. Data including general demography, final refraction, visual outcome, mode of refractive correction, presbyopia addition, and associated conditions were recorded and analyzed using SPSS-14 software.

Results: Out of 1917 cases, refractive error analysis was done in 1224 cases with refractive errors (RE) on right phakic eyes. 665 (54.3%) were females and 559 (45.7%) were males. The mean age of presentation was 32.6 (95% confidence interval (CI) 31.4 to 33.8) years ranging from 3 to 105 years. Most of the participants (81.8%, n=1001) were from Seenu Atoll. Mean best-corrected visual acuity (BCVA) was 0.89 (95% CI 0.87 to 0.90). In 8.7% (n=107) cases, BCVA was ≤6/12; commonest cause for this was cataract (64.5%, n=69). Only 49 (4.0%) cases were corrected with contact lenses and the rest of the cases were corrected with spectacles.

The most common type of RE was astigmatism (66.5%) followed by simple myopia (21.2%). Among the astigmatic eyes, the commonest type was compound myopic astigmatism (47.2%). Considering the spherical equivalent RE, 1167 (95.3%) eyes had RE among which 801 (68.6%) were myopic. Mean spherical equivalent RE was -1.1 (95% CI -1.0 to -1.3) D. The females had significantly higher mean spherical equivalent RE than the males (t test, p = 0.001). Presbyopia correction was prescribed to 467 cases. The Mean presbyopia addition was 1.9 (95% CI 1.4 to 2.3) D.

Discussion: Astigmatism was the commonest type of refractive error. Considering the spherical equivalence, Myopia was more common than Hyperopia.

14 A study on the relative peripheral refractive error in elementary school students in Taiwan
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**Purpose:** To determine and analyze the relative peripheral refractive error (RPRE) in the myopization of elementary school students in Taiwan.

**Methods:** 395 healthy Grades 1 to 6 (from 7-12 years of age) students with no ocular diseases participated in the study. The refractive error ranged from +2.00 to -9.00 D with an astigmatism of ≤ 4.00 D and the best corrected visual acuity, ≥20/20. Open-field auto-refraction was conducted with the visual target located at 6m in the central/foveal position and also horizontally relative to the fovea, at 10o, 20o, and 30o, both nasally and temporally. Statistical analysis was performed between the Grades and also among the refractive groups - the latter divided into hyperopia, emmetropia, mild myopia (up to -0.50D), moderate myopia (-2.01 to -4.00D), and high myopia (worse than -4.01D).

**Results:** The spherical equivalent (SE) of the RPRE showed significant difference between the Grades (F=78.833, p<0.001), most notably that between the 5th and the 6th Grades, but no difference was noted between the two genders or the extent of astigmatism (either J0 or J45). The SE of the RPRE was also significantly different between each refractive group, and between different retinal positions. The latter indicated, temporally: T10o: F= 18.814, p <0.001; T20o: F = 24.048, p <0.001; and T30o: F = 26.994, p <0.001; and nasally: N10o: F = 10.769, p <0.001; N20o: F = 8.351, p <0.001; and N30o: F = 17.597, p <0.001, and the most pronounce change was from T20 o to T30 o. In addition, the RPRE of the hyperopic group exhibited myopic refractive patterns, while the myopic groups, hyperopic refractive patterns.

**Conclusions:** Our study has demonstrated that the RPRE on the temporal side had more variability than the nasal side. This result is opposite to previous findings by others. In terms of myopization, the interaction of both developmental and peripheral variables would appear to decide the outcome of the RPR error. This information can form the basis for the future design of optimal myopic correction.

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*Ocular complaints associated with cycloplegic myopia control among elementary school students in Taiwan*

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**Purpose:** To investigate both objective and subjective responses associated with cycloplegia from the use of cycloplegics for the control of myopia among elementary school children in Taiwan.

**Methods:** 1,067 students from 7 to 12 years old, with no eye diseases and also otherwise healthy participated in the study. The ocular examination included pupillary response to light, habitual near visual acuity, manifest refraction, and best corrected visual acuity. In addition, students and their parents were asked to fill out a questionnaire on the use of cycloplegics and the associated visual complaints.

**Results:** No significant gender difference in the use of cycloplegics (χ2=1.888, p=0.389). The percentages of the cycloplegics users were: Never, 63.8%; long-term past use, 21.4%; and present use, 14.7%. The highest usage was seen in Grades 5 (20.5%), 6 (17.8%), and 2 (17.1%). Cycloplegic users showed a decrease of myopia in the low myopia group (-0.50 to -3.00D), 31.9%; mild myopia group (-3.00D to -6.00D), 29.1%, and high myopia group (worse than -6.00D), 14.3%. A lag of optical correction was also observed in that only 33.3% of the current user group wore prescription spectacles, whereas 57.7% had no optical correction. A comparison between cycloplegic users and non-users showed that the former group had more photophobia complaints during outdoor activities than the latter group (OR=6.575, CI=3.699–11.687). Reasonably, the percentage of the user group who wore sunglasses or
photochromic lenses during outdoor activities was significant higher than the non-user group (11.7% vs 4.0%, OR=3.209, CI=1.272~8.096). In addition, the user group had worse habitual near visual acuity (OD: OR=2.239, CI=1.309~3.830; and OS: OR=2.251, CI=1.310~3.867), and worse best corrected visual acuity (OD: OR=2.955, CI=1.174~7.435; and OS: OR=2.618, CI=1.162~5.899).

Discussion: Age-related increase in the prevalence of myopia appears to continue despite the common practice of topical cycloplegic therapy in Taiwan in recent decades. There was also no implementation of timely correction or protection against solar irradiation. We recommend that following vision screening, the students and their parents be supplemented with ocular health education or even the direct provision of optical prescription to the students.

The effect of low addition glasses relationship between eye fatigue and high frequency components of accommodative microfluctuations
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Purpose: In order to reduce eye fatigue caused by the use of personal computer or tablet devices, the attention of low correction on myopia and progressive power lenses for younger people has been drawn. Therefore, an experiment made objectively on a group of young people with strong accommodation by Accommodation Refractometer Speedy-i. With this device, by the frequency of occurrence of high-frequency component (HFC) of accommodative microfluctuations, it is possible to observe the tension of ciliary muscle. The transition of HFC with the application of low addition on the device was also examined. Further, we compared the subjective symptom between single-vision glasses for distance and low addition glasses.

Methods: 21 subjects (42 eyes) aged between 18 to 27 years with amplitude of accommodation over 8D are studied. Visual targets are set on infinity, 1m, 50cm and 33cm optically. The fluctuation of refractive value of subjects had been measured under 4 conditions where the accommodation stimulus set at 0D, 1D, 2D, 3D. Re-measurement was made with a +1.00D addition lenses setting on the device, and comparison of the frequency of HFC was performed. 2 pairs of glasses of full prescription and +1D addition on full prescription were prepared for the subjects whose HFC had frequently appeared. A survey was made based on the changes in subjective symptoms.

Results and Discussion: According to the measurements by accommodative function analysis equipment, the occurrence of accommodative tension was 55%. Comparing to full prescription, occurrence of HFC had decreased when a +1.00D addition was applied which means tension is reduced significantly. To decrease the appearance of HFC, there are examples that a +1.00D addition was applied on subjects. Effectiveness of low correction of myopia or progressive power lenses can be expected.

The effect of progressive lens for children by downward deviation
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Purpose: The purpose of the research is to clarify the effect of downward deviation to myopic progression for myopic children that wears progressive lenses with an addition of +1.75D for a six months period.
**Methods:** Eighty subjects (aged eight to twelve, spherical power -0.50~-5.00D) including progressive lens group (42 subjects) and single vision lens group (38 subjects) were randomly arranged. Also, by using digital camera, we measured downward deviation during reading by subjects; after one week, two weeks, and four weeks. We measured the progression of refractive error by using objective refraction (RM 8800, cycloplegic refraction by using Mydrin-P) and compared to change of axial length measured by IOL master.

**Results:** Mean downward deviation of progressive lens group during the near work was 7.14±1.19mm and the bigger the downward deviation, the less the change of axial length (r=-0.47, p=0.00). Myopic progression for six month between progressive lens group and single vision lens was -0.25±0.22D, -0.37±0.23D respectively. This shows significant difference (p=0.02) and change of axial length between PAL group and SV group also signals significant difference (p=0.03) and its figure was 0.13±0.10mm and -0.19±0.14mm respectively.

**Conclusion:** By wearing progressive lenses for six months, the myopic progression slowed compare to single vision lens. An important aspect is to realize the effect of progressive lenses on Myopia progression, and recognize the effect of downward gaze during near work.

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**Accommodative microfluctuations – absolute or relative indicator of visual fatigue?**

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**Purpose:** In literature, visual fatigue is mostly measured using relative indicators and only very few studies have made use of absolute indicators. The aim of this study was to compare and assess efficacy of microfluctuations of accommodation as both absolute and relative indicators.

**Methods:** For relative measurement, 10 emmetropes (age range 23-40 years; not presbyopic) performed 60 min of visual search task displayed on an LCD monitor placed 40 cm away from the eye. During the task, 20 sec fixation target was displayed at the beginning, middle and at the end of the task. Subjects were made stable on head and chin rests. Real-time recording of refraction was done throughout the task using PowerRef II and data were analyzed from refraction recorded during fixations only. Subjective measurement of visual fatigue was done using questionnaire before and after the task. Another 10 emmetropic subjects of the same age range were recruited for absolute measurements wherein refraction was measured by PowerRef II while subject fixated for 2 min at the fixation target on 3 different days in a week. Both experiments were carried out during 4–6 pm. Accommodative microfluctuations (Low frequency component (LFC) 0.29Hz-0.9Hz, Middle frequency component (MFC) 1.0Hz–1.6Hz and High frequency component (HFC) 1.7Hz–2.5Hz) were acquired using FFT.

**Results:** Subjective measurement of visual fatigue showed significant increase after the task (Wilcoxon signed rank test; p<0.05). Accommodative microfluctuations did not show any significant change across the week for either LFC (OD p=0.91; OS p=0.17), MFC (OD p=0.91; OS p=0.17) or HFC (OD p=0.91; OS p=0.17) whereas there was significant increase after 60 min of task (p<0.05) except LFC (p=0.14) and HFC (p=0.17) for right eyes.

**Conclusion:** Relative accommodative microfluctuations are apparently more reliable than an absolute indicator.

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**Size lens prescription to aniseikonia that occurred after retinopexy**

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**Presenting Signs and Symptoms:** A patient with an intraocular lens in both eyes suffered from retinal detachment in the fovea of the right eye. Although the patient's visual acuity was recovered by retinopexy, his binocular vision became difficult due to aniseikonia.

**Management Plan:** He regained the comfortable binocular vision by prescribing size lens using a progressive multifocal lens.

**Discussion:** Most patients complain of aniseikonia after retinopexy. However, since the symptom tends to ease with time, a patient's quality of vision is hardly taken into consideration during progress observation. We consider that it is important to prescribing size lenses as one of the options for improvement in quality of vision.

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**Optical performance after implantation of monofocal and multifocal aspheric intraocular lenses**

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**Purpose:** To compare postoperative vision and objective visual quality after implantation of multifocal aspheric and monofocal aspheric intraocular lenses (IOL).

**Methods:** Nineteen patients (30 eyes) and 28 patients (35 eyes) implanted with multifocal aspheric (ReSTOR SN6AD3) and monofocal aspheric (HOYA PC-60AD) IOL respectively, were enrolled. Ocular optical quality was assessed using a double-pass system (Optical Quality Analysis System) with a 4-mm pupil diameter and the modulation transfer function (MTF), objective scatter index (OSI) and strehl ratio were compared between two groups. Ocular optical quality was analyzed preoperatively and 1 week, 1 month and 3 months postoperatively. A Student's independent t-test analysis was used for the analysis.

**Results:** The corrected distance acuity (logMAR) was 0.39±0.19 preoperatively and 0.07±0.06 at 3 month postoperatively in multifocal group and was 0.43±0.21 preoperatively and 0.08±0.08 at 3 month postoperatively in monofocal group. Two groups were not statistically significant at 3 month (p=0.551). MTF cut off, OSI and strehl ratio were significantly getting better in 1 month of post operation in the multifocal IOL group and in 1 week of monofocal IOL group. However, there was no significant differences in OSI, MTF cut off, and strehl ratio values in 3 months of post operation between the two groups ( p=0.197, p=0.094 and p=0.142, respectively).

**Conclusions:** The improvements in corrected distance visual acuity were not statistically different between multifocal and monofocal groups, however, optical quality provide by the multifocal IOL recovered more slowly compared with monofocal IOL.

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**Comparison of visual adaptation between progressive lens for children and single vision lens**

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Purpose: The purpose of the research is to compare initial visual discomfort of myopic children between Progressive lens with a near addition of +1.75D and single vision lens.

Methods: Eighty subjects (aged eight to twelve, spherical power -0.50~-5.00D) including progressive lens group (42 subjects) and single vision lens group (38 subjects) were randomly arranged and surveyed about adaptability and visual discomfort conducted after a week, two weeks, and four weeks.

Results: There is no significant adaptability difference between progressive lens and single vision lens after a week. The questions of questionnaire were as follows.
Q1. Did you have a problem when you wear spectacles? Q2. Can you read words written on a blackboard clearly after wearing spectacles? Q3. Did you have a problem to see clearly when you look from blackboard to desk after wearing spectacles? Q4. Did words look different after you wear spectacles? Q5. Did you experience a problem when you go up the stairs or go down the stairs? Q6. Did you feel dizziness or nausea when you look at something near? Q7. Did you have a problem when you look at a distant object after wearing spectacles? Q8. Did you experience a problem when you spend a length of time on the computer? Q9. Did you have a problem when you enjoyed outdoor activity?

Conclusion: The visual discomfort of progressive lens and single vision lens is similar. Progressive lens is a safe product for slowing myopic progression without any concern of visual discomfort.

Optical aberrations post cataract surgery with non- aspheric IOL implantation
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Purpose: To evaluate the changes in optical aberrations after cataract surgery using Hartmann Sachs aberrometer in patients implanted with non-aspheric intraocular lens implantation.

Methods: 94 eyes of 94 patients with senile cataract nuclear sclerosis grade 2-3 with no retinal pathology were evaluated for total ocular aberrations using Hartmann Sachs aberrometer. Lower order and higher order aberrations were measured. All patients underwent a clear corneal phacoemulsification with implantation of a foldable non-aspheric IOL from a 2.8mm incision. Optical aberrations were measured at 1 month after surgery. Pre-operative and post-operative aberrations were compared.

Results: All patients had an uncorrected visual acuity of 6/6 at 1 month after surgery. Lower order aberrations decreased significantly after the surgery. Higher order aberrations (up to 12th Zernike’s order) decreased from the pre-operative values but there was no statistically significant difference between from the pre-operative value.

Conclusion: Despite reduction in the ocular aberrations after cataract surgery, higher order aberrations still remain high in patients undergoing cataract surgery with implantation of non-aspheric IOL. This can affect the visual quality in patients after surgery thus warranting the use of aspheric IOLs to improve the visual quality.

Transition lenses and their effect on visual acuity, cornea thickness, and conjunctival goblet cells under the influence of ultraviolet light exposure
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Purpose: This study investigated the bioprotective effects of anti-UV coating lenses against UVB-induced visual acuity impairment and conjunctival goblet cell degeneration in a mouse model.

Methods: Mice were randomly divided into 4 groups: (1) blank control without UVB exposure, (2) with UVB exposure, without lens protection, (3) with UVB exposure and with UV protective lens, and (4) with UVB exposure, and covered with UV protective + photochromic coating lens (Transitions lens). The mice of groups (2), (3) and (4) were exposed to daily UVB for a 7-day period. Visual acuity assessment was performed, followed by cornea surface grading. H-E staining, PAS staining, and immunohistochemistry were performed for cellular assessment and inflammatory marker detection.

Results: UVB exposure lead to corneal surface damages, including reduced smoothness and transparency, impaired cornea sensitivity and visual acuity. Histological analysis revealed that corneal thickness was decreased and fewer conjunctival goblet cells were observed. With UV protective coating lenses or Transitions coating lenses to shield against UVB irradiation, the tissue damages and altered cellular and inflammatory markers in the cornea and conjunctiva were all ameliorated.

Discussion: This study demonstrated the bio-protective effects of anti-UV coating lenses by using the mouse model. This mouse model may be used widely for in vivo assessment of UV shield efficacy.

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Accommodative responses with monofocal and multifocal contact lenses: a pilot study
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Purpose: To evaluate induced changes in accommodative response with monofocal and multifocal contact lenses (CLs).

Methods: Eleven young contact lens wearers (22.91 ± 3.69 years; 4 females, 7 males) were enrolled and fitted with monovision and center near type multifocal (AirOptix multifocal Low Add) CLs. After wearing the contact lenses for a week in each of these modalities, the following assessments of visual function were made: high (100%) and low (10%) contrast ETDRS visual acuity (VA) at distance and near under photopic condition, stereoacuity, accommodative facility, negative relative accommodation (NRA)/positive relative accommodation (PRA), ghost image test and legibility were evaluated, and subjective visual performance was evaluated with questionnaire. All measurements were carried out binocularly and compared with single vision CL wear.

Results: With the single vision CL, binocular high contrast VA (-0.136±0.072) and low contrast VA (0.018±0.065) at distance and low contrast VA (0.1±0.064) at near was the best, however, for the near high contrast VA (-0.049±0.066) was best with monovision. Differences were not found among the single CL, monovision and multifocal CL in accommodative facility, NRA/PRA and stereoacuity. Legibility was shown the fastest and ghost image was the worst with multifocal CL (p<0.05). Differences were not found in the subjective visual performance.

Conclusions: This pilot study suggest that in young contact lens wearers, the monovision and multifocal CLs do not induce large changes in accommodative system compared with the single vision lens.
An evaluation of the “Hula Effect” with daily disposable circle lenses
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Purpose: Lens centration is essential to achieve the desired cosmetic effect of circle lenses. Social networking communities in Korea have identified a phenomenon, labeled the “hula effect,” in which the ring designs of certain circle cosmetic lenses are off-set from the cornea, which may detract from the beauty the user is seeking. The objective of this study was to compare the incidence of the hula effect between 1-Day Acuvue Define (Johnson & Johnson) and Naturelle (Bausch & Lomb Incorporated) lenses.

Methods: Twenty-six subjects were fit bilaterally with each lens type. After lens settling, subjects were instructed to perform a series of eye movements in which they looked up-right, up-left, down-right, down-left, then straight up. Each eye was observed for the hula effect during the eye movements and a photo was taken immediately following. A positive observation of hula was defined as any decentration of the lens in any direction off of the cornea such that the white of the eye was visible between the lens pattern and the iris.

Results: The hula effect was observed in 29 of 52 eyes (56%) wearing Acuvue Define. Eighteen of the 26 subjects (69%) exhibited the hula effect in at least 1 eye with Acuvue Define. Meanwhile, the hula effect was observed in only 1 of 52 eyes (2%) wearing Naturelle. The difference in the incidence of the hula effect between the lens types was statistically significant (p=0.0189). For the 29 eyes exhibiting the hula effect with Acuvue Define, none of those same eyes exhibited the hula effect with Naturelle.

Conclusions: Over half of the eyes wearing Acuvue Define lenses in this study demonstrated the hula effect. Eye care practitioners should dynamically examine the centration of circle lenses with eye movement in various positions of gaze to optimize the wearing experience for their patients.

Using a novel optical bench technique to understand dehydration blur in four commercially available daily disposable contact lenses
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Purpose: Using a novel optical bench technique to analyze the image stability and predicted logMAR retinal image resolution of 4 commercially available daily disposable contact lenses as the lenses dehydrate.

Methods: Twenty -3.00D lenses of each lens type (etafilcon_A [AV Moist], narafilcon_B, nelfilcon_A, nesofilcon_A) were analyzed on an optical imaging bench that uses a 7.8mm radius PMMA model cornea that relays the retinal plane image of a target (US Air Force) to a CCD camera. Each lens was blotted to remove excess packaging solution and images were acquired every 10s, as the lens is dehydrated, up to 180s following application of rewetting drops to simulate the tear film. A pattern-matching algorithm was used to calculate the predicted logMAR score of the images relative to the time-zero images.

Results: A one-way ANOVA showed a statistically significant difference (p<0.001) between the nesofilcon_A lens compared to nelfilcon_A, narafilcon_B and etafilcon_A, where the overall predicted mean logMAR scores were -0.009, 0.116, 0.136 and 0.182. Analyzing the time-0 images, there was a
statistically significant difference between nesofilcon_A and nelfilcon_A (p<0.03) with mean predicted logMAR scores of -0.11 and -0.05, respectively. For the time 10s images (shorter than blink rates associated with reading/computer use), there was a statistically significant difference (p<0.001) between the nesofilcon_A lens compared to nelfilcon_A and etafilcon_A with mean predicted logMAR scores of -0.10, -0.02, -0.03, respectively.

**Discussion:** The nesofilcon_A lenses exhibited better optical image quality than the other lenses tested. The nesofilcon_A lens showed a more consistent and slower reduction in predicted retinal image quality over time compared to narafilcon_B and etafilcon_A lenses. Within 10s, there was a predicted 4 letter difference between the nesofilcon_A lens and nelfilcon_A and a 3.5 letter difference for etafilcon_A.

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**The effects of soft contact lens wear on corneal thickness, curvature and surface regularity**

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**Purpose:** Contact lenses have various cosmetic and optical advantages over spectacles. However, long term lens use might affect the normal corneal anatomy and physiology in a variety of ways. These effects depend upon the type, duration and the compliance of the lens use. The aim of this study was to determine the effect of soft contact lens wear on corneal thickness, curvature, and surface regularity.

**Methods:** A total of 138 eyes of 69 subjects wearing contact lenses for more than 1 year were evaluated. One eye of each case was randomly selected for the analysis. Nidek Magellan Mapper corneal topography system was used to evaluate the anterior corneal topography. Central corneal thickness was measured using Quantel Medical Axis II PR within standard deviation of ±5 µm of the five measurements.

**Results:** Corneal topography and central corneal thickness measurements on 138 eyes of 69 subjects were performed. The mean age of the cases and controls was 24.76 ± 5.52 25.13±5.49 years respectively. The mean duration of contact lens wear was 4.83±4.19 years. The mean CCT in case and control group was 527.56±37.40 microns and 544.60±26.10 microns respectively. The mean central corneal thickness in the cases was significantly less by about 16.31 µm in comparison to controls (P <0.05, 95% CI of the difference: 9 µm - 24µm). The SRI and SAI indices were significantly greater in contact lens wearers than in the control group (P = 0.00 for both SRI and SAI).

**Conclusion:** Regular corneal pachymetry and topography assessments are mandatory in soft contact lens users as long term lens wear appears to reduce the central corneal thickness and increase the corneal surface irregularity.

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**Water gradient properties of delefilcon A contact lenses**

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**Purpose:** To assess the unique attributes of delefilcon A water gradient contact lenses. In particular, the gradient water content and gradient modulus of the delefilcon A surface are characterized and presented.

**Methods:** Atomic Force Microscopy (AFM) and Neutron Reflectometry were used to characterize the gradient modulus profile and gradient water content of the delefilcon A surface. Fluorescent Laser
Confocal Microscopy was used in conjunction with tagged hydrophilic copolymers to confirm the gradient surface on the delefilcon A lens.

**Results:** Neutron Reflectometry measurement of the lens surface copolymer showed that the hydrophilic surface polymer has a high water content of 80 wt%, compared to 33% water content in the lens core. AFM and Laser confocal microscopy studies showed that delefilcon A lenses possess a unique gradient water content region of 6 micron thickness surrounding the entire lens. It was found that within the gradient surface region, material composition underwent a gradual transition from the SiHy rich core to increasing levels of highly hydrophilic polymer at the lens surface. AFM modulus scans of the lens cross section showed that the gradient surface region is substantially softer than the lens core, consistent with the gradient polymer composition and gradient water content observed in the surface region. AFM surface scans of the delefilcon A lens showed that surface modulus of the lens is at least three orders of magnitude lower than that of the lens core, resulting in a very soft and compliant surface.

**Discussion:** It was demonstrated that delefilcon A lenses possess a unique gradient surface where the water content, modulus and composition underwent gradual transition from the lens core to the lens surface. These structural attributes enabled an ultrasoft lens surface region with very high water content on delefilcon A lenses.

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Clinical and practice impact of wearing silicon hydrogel contact lens at regular, shorter intervals
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**Purpose:** To study CL material properties which contribute to long term clinical benefits for Safe and Healthy use of wearing Contact Lenses.

**Methods:** Review of current literature on contact lens material properties, replacement schedule on eye health and patient acceptance. There is a common understanding that Silicon Hydrogel is the best material for healthy long term contact lens use. Apart from an increase in Oxygen available to the cornea, they have lower water content which helps in symptoms of dryness. When it comes to CL wearing comfort, many patients find that all Silicon Hydrogel lenses do not offer the same wearing comfort and long term health benefits.

**Results:** Different CL manufacturers use different technology to bring out the best of Silicon Hydrogel polymers. It is not specific properties of the material that matter but an optimal balance of critical properties which make the lens clinically more healthy, safe and more comfortable to wear. In addition to this, shorter replacement cycles mean less surface deposits leading to better ocular health and overall comfort.

**Discussion:** This presentation will discuss the Silicon Hydrogel material properties, what balance is necessary to achieve maximum impact on eye health and wearing comfort. It will also help Optometrist understand what factors they should consider when recommending contact lenses so their patients can continue to wear contact lenses healthily.

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Effect of pigment in daily disposable etafilcon A limbal ring contact lenses (JJVCI) on oxygen permeability (Dk) and corneal oxygen availability
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Purpose: “Limbal ring” contact lenses continue to grow in popularity in the Asia-Pacific region with many brands now available. One concern that eye care providers (ECPs) voice regarding these lenses is eye health. Daily disposable etafilcon A limbal ring contact lenses (DDeALR) (JJVCI) contain FDA-approved pigments fully embedded within the lens material in the limbal region of the lens to enhance the eye’s natural beauty. The effect the limbal pigment may have on oxygen permeability and/or conjunctival redness can be a specific concern for ECPs.

Methods: Oxygen permeability was measured using a polographic technique compliant with ISO-18369-3:2006. Results were compared to the Dk value for the control lens, DDeALR (JJVCI). Additionally, 100 subjects were evaluated in a clinical trial for differences in conjunctival injection compared to their habitual lens after 7-9 days of wear.

Results: Lenses made with DDeALR pigments centrally were measured to have an edge corrected Dk = 19.7 x 10^-11 (cm^2/sec)/(ml O2 x mm Hg) at 35°C, which is within the tolerance of DDeALR (edge corrected Dk = 21.4). This Dk value allows for 88% of all oxygen available to reach the cornea when the eye is open (oxygen flux). Conjunctival injection after 7-9 days of lens wear with DDeALR demonstrated no change from baseline. For bulbar redness, 99.5% of subjects had a maximum Grade1 or less compared to 97% at baseline. For limbal redness, 89% of subjects had a maximum Grade1 or less compared to 79.5% at baseline.

Discussion: Pigment contained in DDeALR contact lenses does not affect either the transmission or availability of oxygen to the cornea or surrounding tissue for healthy lens wear. A clinical trial confirming the effect of lens pigment on corneal swelling is currently being conducted to further provide corneal health information for these products.

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Comparison of induced corneal thickness changes after wearing daily disposable soft contact lens and daily disposable color contact lens
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Purpose: To investigate the clinical performance of fully integrated printing color contact lens(A lens) and daily disposable clear soft contact lens(B lens).

Methods: 48 subjects (22.25±4.50 years old, male 16, female 32) were recruited for this study. Change of cornea curvature and thickness were measured after wearing A&B lens respectively. Wearing time was limited to 8 hours/day and 48 hours washing time was applied between wearing two lenses. Flat and steep cornea curvature was measured with CANON RK-2(CANON). Superior, Inferior, Nasal and Temporal cornea thickness, 5mm away from cornea center, were measured with PENTACAM (Oculus).

Results: After 8 hours of wearing A lens, measured Steep K, Flat K and Mean K was 7.70±0.32 mm, 7.93±0.31mm and 7.81±0.31mm respectively. With B lens, Steep K: 7.69±0.32mm, Flat K: 7.93±0.30, mean K: 7.81±0.30mm was measured respectively. Between two lenses, no significant induced difference of corneal curvature was found (Steep K: p=0.250 Flat K: p=0.349 Mean K: p=0.594). After 8 hours of lens wearing, measured 5 point thickness was as bellow: center thickness: 562.56±42.50µm with A lens, 561.29±42.59 µm with B lens (p=0.184), nasal part: 647.77±43.87 µm (A lens), 645.77±4.29 µm (B lens)(p=0.164), temporal part: 653.74±44.48 µm (A lens), 651.55±44.11 µm (B lens)(p=0.220), superior part: 695.58±49.76 µm (A lens), 692.83±52.63 µm (B lens)(p=0.217), inferior part: 641.20±40.60 µm (A lens), 640.20±41.61 µm (B lens)(p=0.545). When it comes to a difference of corneal thickness after wearing two lenses, there was not any induced difference.
Conclusions: Keeping compliance (wearing time and modality) of daily color contact lens manufactured with fully integrated printing technology (Nelfilcon A), induced cornea thickness changes were not significantly different from clear lens (Nelfilcon A) which has same parameter. But, pigmented area can cause poor visual field and cornea-conjunctiva irritation so broader follows up study for long-term wearing is needed.

Safety of cosmetic soft contact lenses
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Purpose: A meta-analysis was conducted to evaluate the safety of cosmetic contact lenses in a large number of patients across 6 clinical trials that varied from 1 week to 3 months duration.

Methods: Lenses tested in the 6 studies included: Naturelle limbal ring daily disposable (2 studies), Lacelle limbal ring daily disposable (1 study), Lacelle colored cosmetic daily disposable (1 study), Lacelle limbal ring planned replacement at two weeks (1 study), and Alamode traditional/annual colored cosmetic lens (1 study). All patients were of Asian descent. Slit lamp examination (including epithelial edema, epithelial microcysts, corneal staining, bulbar injection, limbal injection, upper lid tarsal conjunctival abnormalities, corneal neovascularization, and corneal infiltrates), high contrast logMAR visual acuity with lenses, lens wearing time, and lens centration results from 6 consecutive, prospective clinical studies are presented in this report.

Results: 871 subjects (1742 eyes) and 23 unique clinical investigators participated in the six studies, with an average completion rate of 96.4% across all studies. The mean age of patients was 26.8 ± 6.6, and 86.7% of participants were female. The total number of slit lamp exams across the six studies was 2456 visits by eye (1228 visits by patient). There were no slit lamp signs > Grade 2 for any finding, with the exception of corneal staining in one study. In this study, grade 3 corneal staining was noted in 1 eye (0.1%) at follow-up visit 1 and 4 eyes (0.6%) of all eligible dispensed eyes at follow up visit 2, with no eyes requiring medical treatment. No adverse events were reported during any of the trials.

Conclusions: The cosmetically tinted lenses evaluated in this meta-analysis appear to be safe when properly prescribed by an eye care professional and the contact lenses are used in a compliant manner.

The opportunity for astigmatic lens practice: the science and the trends ahead
Quan Wei Ng
Johnson & Johnson Vision Care, Asia Pacific

Purpose: This study aims to identify business opportunities for soft toric lenses and to give eye care professionals the latest insights on factors that contribute to good on-eye performance of current soft toric lens designs.

Methods: An extensive review of the results/data from current clinical work & market research are leveraged upon for this topic.

Results: From our TV sets to our smart-phones' screens and camera lenses, consumers nowadays have an increasing demand for high visual quality. In two of the biggest economies in the world, there are 35 million households that have the capability of High Definition Televisions (HDTV). However, only around 2% of all contact lens wearers in Asia Pacific are fitted with soft toric lenses for optimal visual acuity. This is due to many wearers with astigmatism opting out of wearing contact lenses. Studies also showed 65% of contact lens dropouts have astigmatism. This is a huge opportunity to provide higher
quality of vision to consumers and to re-instill faith to the dropouts. Factors affecting soft toric lens fits, such as inter-canthal angle versus the orientation, eye shapes and dynamic forces, will be explored accordingly. Effective trial lens fittings are extremely important to increase the chances of a successful toric lens experience that leads to enhanced patient satisfaction & loyalty.

**Discussion:** Consumers are prepared to pay more for higher resolutions TVs, camera lenses and eye-front screens. By offering them the chance to enhance the quality of their vision, consumers will certainly be able to get the most benefits out of the technological device they are paying a premium for. Eye care professionals with the correct and latest knowledge of soft toric lens will be the one helping consumer to fulfill that ever increasing visual demand and at the same time, grow their businesses.

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Toric lens rotational stability between toric lens for simple myopic astigmatism and toric lens for compound myopic astigmatism

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**Purpose:** To compare toric lens rotational stability between toric lenses with powers designed to correct simple myopic astigmatism.

**Methods:** Twelve participants were recruited. Inclusion criteria were no ocular complication and having less than 0.3mm of difference in corneal curvature between the two principal meridians, in other words to have minimal corneal astigmatism. The mean refractive error was -0.75DS ±0.37 / -1.20DC ±0.45 and axis was 3.83±7.85. The mean corneal curvature was 7.96 ± 0.27mm horizontally and 7.73 ± 0.25mm vertically. For each eye, two toric lenses (Plano/-0.75DC designed to correct simple myopic astigmatism and -1.00DS/-0.75DC designed to correct compound myopic astigmatism) were fitted for measurement of lens rotation.

**Results:** There was statistically significant differences between two toric lenses (p=0.003). The mean rotation was 21.42±4.62 degree for the lens designed to correct simple myopic astigmatism and was 9.17±2.49 degree for the lens designed to correct compound myopic astigmatism.

**Conclusion:** This study demonstrated that toric lens for simple astigmatism had significantly larger rotations than toric lens for compound astigmatism for corneas with approximately spherical corneal curvatures.

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Rotational stability and visual performance of daily disposable etafilconA with moisture technology toric contact lenses on Asian eyes

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Johnson & Johnson Vision Care

**Purpose:** Due to differences in ocular and eyelid anatomy, soft toric contact lenses may demonstrate different fitting characteristics on Asian eyes compared to Caucasian eyes. The objective of this study was to investigate whether daily disposable etafilconA with Moisture Technology Toric Contact Lenses fit satisfactorily on Asian eyes.

**Methods:** Daily disposable etafilconA with Moisture Technology Toric Contact Lenses were dispensed for one day of wear. Only subjects of Asian descent were enrolled in the study. All subjects were habitual soft contact lens wearers in both eyes with astigmatism (cylinder correction) between 0.75 D and 2.25 D after vertex correction. Lens rotation was measured at 1 minute, 3 minutes, and 15 minutes following insertion, and again at the end of the wearing day (at least 6 and no more than 12 hours after
Monocular distance visual performance (logMAR) was measured using ETDRS charts while subjects wore their best corrected spherocylinder refraction at the fitting visit and again following settling of the study lenses at the same visit. Monocular visual performance following settling was compared to that with the best corrected sphero-cylindrical refraction using least-squares means from a linear mixed model.

**Results:** A total of 66 subjects completed the study. At 1 minute post-insertion, lenses were within 10 degrees of correct orientation for 92% of subjects. At 15 minutes post-insertion, this increased to 98% of subjects. All lenses demonstrated less than 8 degrees of rotation with eye versions at the end of the wearing day. Monocular visual performance with the study lenses following settling was equivalent to visual performance with the best corrected sphero-cylindrical refraction (-0.105 vs. -0.098 LogMAR respectively; difference [95% Confidence Interval]: -0.007 [-0.019, 0.005]).

**Conclusion:** Daily disposable etafilconA with Moisture Technology Toric Contact Lenses settle quickly, maintain stable orientation throughout the day, and provide good visual performance on Asian eyes.

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**Korean ECP's perception and behavior towards toric contact lenses**  
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**Introduction:** The toric contact lens market in Korea has been growing fast but falls below the current global average toric contact lens penetration. The aim of this pilot study is to investigate Korean ECP's perception and behavior towards toric contact lenses.

**Methods:** One-on-one interview survey method was conducted for 47 opticians (Seoul n= 20 and other cities (Busan, Daegu, Daejun) n=27) in this pilot study. Subjects (opticians) were selected from Seoul and other cities, such as Busan, Daegu and Daejun so that we could further evaluate other possible factors among cities in Korea. All the subjects selected had more than 2 years working experience in optical industry and were in charge of contact lens in their practices. The survey questionnaire consisted of a series of questions related to toric contact lenses fitting.

**Results:** About 60% ECPs prescribe toric contact lenses to astigmats with more than -0.75 DC without hesitation in Seoul. Similar findings were evident in other cities. Furthermore, Axis rotation was the main concern of 59% ECPs in Seoul and 55% ECPs in other Korean cities when fitting toric contact lens, and they were not comfortable with fitting toric contact lenses for this reason.

**Conclusion:** ECPs in Seoul (60%) proactively fitted toric contact lenses comparing with ECPs (56%) in other Korean cities and it may explain the higher toric contact lens penetration in Seoul than other Korean cities. In other words, the potential of toric contact lens market was not yet fully achieved. Axis rotation and ECPs' confidence in fitting toric contact lens were key factors on development of toric contact lens in Korea. Advanced stability system of toric contact lens and ECP education on toric contact lens fitting are essential to develop toric contact lens in Korea. Further investigation on ECPs' behavior may be needed.

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**Antimicrobial synergistic effect of Polyhexamethylene Biguanide (PHMB) and Epigallocatechin Gallate (EGCG) against micorbials associated with contact lens solution, and non-cytotoxicity on the cultured human corneal epithelial cell**  
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**Purpose**: To evaluate antibiotic effects of Epigallocatechin gallate (EGCG), green tea extracts and Polyhexamethylene Biguanide (PHMB) mixture, and their cytotoxic effect on the cultured human corneal epithelial cell (HCPpiC).

**Methods**: After inoculating bacteria and fungi ISO 14729 required in a liquid culture media, and activated for 24 hours at the optimal temperature for each strain, activated strains were incubated on media containing 0.0000125~0.0004% of PHMB and 0.0025~0.3% of EGCG. Optical density of the culture media was measured at 600nm for antimicrobial activity. Cultured HCPpiC with Corneal Epithelial Cell Medium (CEpiCM) in 384 well plates were exposed to mixture of EGCG and PHMB for 30, 60, 120 and 240 min to evaluate the cytotoxic effect. After incubation HCPpiC were fixed with 4% of paraformaldehyde and stained nucleus with DraQ 5, cytotoxic effect of mixture on the HCPpiC was determined using confocal microscopy system (PerkinElmer, USA).

**Results**: The PHMB/EGCG mixture showed high microbial activity against ISO required strains, MIC of mixture was 0.00005/0.05%, which is 25% of that of PHMB. The proliferation of HCPpiC and damaged cell number with the EGCG/PHMB mixture were similar with the control group.

**Conclusions**: PHMB and EGCG mixture showed synergistic antimicrobial activity against IOS required infectious microbes and showed non-cytotoxic effect on the HCPpiC, that mixture could lower PHMB concentration and be a potent and effective antibiotic for contact lens care solution.

**Effectiveness of oregano (Origanum vulgare) leaves crude extract as disinfecting solution for soft contact lens**

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**Purpose**: Oregano is known to be one of the most effective and well known herbal medicines in the Philippines. The researchers determined the effectiveness of oregano leaves crude extract as disinfecting solution for soft contact lens.

**Methods**: Experimental method of research was used to extract the active ingredients with antiseptic property. The following methods were done: Collection of plant sample, air dried Oregano leaves(50g), maceration (2-3 days), Sox let extraction (5 days), and evaporation of alcohol from the extract. Preliminary, Physical, Biological and Chemical tests were conducted.

**Results/Conclusions**: Oregano leaves crude extract contained thymol, carvacrol, tannins, glycosides and pigments responsible for anti-microbial effect; pH of extract was adjusted using monobasic potassium phosphate buffer but the amount of buffer is too high due to high concentration of extract. Tonicity of crude extract with buffer and the least possible concentration solution are almost the same as the tears’ tonicity as proven in its action in the red blood cells. Evident sensitivity of crude extract is based on its reaction to pathogens (Pseudomonas aeruginosa, Staphylococcus aureus, Serratia marcescens and Escherechia coli) present in soft contact lens. The higher the crude extracts concentration, the higher bacteriostatic action. Solutions A,B and distilled water did not produce any zone of inhibition, an indication of insensitivity to three pathogens while oregano crude extract produced zone of inhibition indicating its effectiveness against the pathogens except for Serratia marcescens. All solutions have rinsing quality and oregano crude extract stays longer in contact lens. Products A and B have no effect on the color and clarity of the lens while the crude extract has slight discoloration on the lens and became slightly blurred. It is recommended that adjustment of the pH of the extract to obtain isotonicity and purification of the extract to near colorless with the same anti-microbial effect to eliminate staining on the contact lens be done.
Impact of corneal eccentricity in orthokeratology
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Purpose: To investigate the effect of corneal eccentricity in the response of overnight orthokeratology (orthoK-K).

Methods: One-hundred eighteen healthy subjects aged 8 to 33 years who had no eye diseases and could wear ortho-K contact lenses at least for 8 hours every day were enrolled in this study. Subjects were fitted reverse geometry ortho-K lenses (Lucide CH 1 lenses, Boston XO) in both eyes. Corneal topography was performed using Oculus keratograph topography (OCULUS, USA) and corneal thickness was measured using Orbscan IIz Corneal topography (Bauch + Lomb, USA). According to their corneal eccentricity the subjects were divided into 3 groups. Group 1 (e ≤ 0.49, 53 eyes), group 2 (e = 0.50~0.59, 104 eyes) and group 3 (e ≥ 0.60, 53 eyes). Unaided visual acuity (VA), refractive error, apical corneal radius, corneal eccentricity and central corneal thickness were evaluated and investigate the impact of corneal eccentricity on the efficacy of ortho-K.

Results: Changes in corneal apical radius and residual refractive error were significantly different among groups (F=5.205, p=0.006, F=3.609, p=0.029, respectively), group 3 showed largest change in corneal apical radius and showed the lowest residual uncorrected VA during the first week of ortho-K treatment. And changes in corneal eccentricity after ortho-K were different (F=7.501, p<0.001) and Group 1 showed the lowest changes.

Conclusions: High corneal eccentricity (high rate of flattening) facilitate the effect of ortho-K in myopia that subjects with a larger corneal eccentricity are expected to achieve rapid VA improvement in a shorter period of treatment.

Visual quality after overnight orthokeratology contact lens wear
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Purpose: To investigate the pre-operative and post-operative objective visual quality after overnight orthokeratology (ortho-k).

Methods: Twenty two patients (24 eyes) satisfying the inclusion criteria (myopia < -4.50D, astigmatism < -1.50D, K-reading: 40.00~46.75 D) for overnight ortho-k. Visual acuity (VA) was measured by using System Chart (SC-2000, Nidek) and converted to logMAR. Objective optical quality measurements were performed using the Optical Quality Analysis System (OQAS Visionmetrics SL, Spain) for modulation transfer function (MTF), strehl ratio, and objective scattering index (OSI). Statistical analyses were performed with SPSS 18.0 (SPSS Inc, Chicago, Illinois) and p value less than 0.05 was considered statistically significant.

Results: The MTF values were 38.20 ± 11.02 pre-operatively, and 34.79 ± 10.30 post-operatively that there was no significant difference (p = 0.262). The strehl ratios were 0.24 ± 0.07, and 0.21 ± 0.07, respectively that there was no significant difference between pre- and post-orthokeratology (p = 0.115). OSI values were 0.38 ± 0.19 and 0.72 ± 0.40, respectively, which were statistically significant (p < 0.05).
According to OSI values, the mean value of VA was 0.04 ± 0.05 logMAR in the over 0.40 OSI group and 0.02 ± 0.04 logMAR in the less 0.40 OSI group that there was no significant difference (p = 0.478).

**Conclusions:** There were no significant differences in the objective visual quality such as MTF and Strehl ratio between pre- and post-orthokeratology. The postoperative OSI value was increased significantly compared with pre-operation, however, increase in the OSI would not influence on the UCVA.

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**Hereditary fundus dystrophies with macular degeneration: a case report**

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**Presenting Signs and Symptoms:** A 60-year-old male presents with hypertension and poor vision in his right eye (OD) due to macula problem, and complaints of reduced vision in his left eye (OS). He reports unusual frequency in walking into nearby objects.

**Objective Measurements:** A comprehensive eye examination was performed, including subjective refraction, visual acuity (VA) at distance and near, confrontation test, ocular health assessment, and Amsler grid test. Visual field and OCT assessment were performed in the follow-up visit.

**Assessment:** He had very poor vision in OD (the best corrected VA: hand movement at 15cm) and good central vision in OS (6/6+2). Confrontation test showed visual loss in all quadrants for OD, temporal and partial nasal field for OS. Amsler grid was normal for OS. In dilated fundus examination, diffuse chorioretinal atrophy in peripheral retina of both eyes and macular degeneration in OD were observed. Humphrey perimetry indicated significant visual field constriction in OS. Visual field test results were consistent with the clinical fundus appearance.

**Case Management Plan:** An updated prescription was given and use of walking stick suggested. The patient was referred to an ophthalmologist who suggested a possible choroideremia. Electrophysiological tests were performed in the second follow-up. ERG and EOG indicated abnormal retinal pigmented epithelial function and no response in rod and cone cells respectively.

**Discussion:** Choroideremia is a rare hereditary fundus dystrophy inherited in X-linked recessive pattern, mainly affecting males. It causes impairment of night vision, progressive loss of vision and ultimately leads to blindness due to degeneration of the choroid and retina. The patient should be followed-up regularly and low vision aids may be used (e.g. Fresnel prism). Genetic counseling and regular eye checks are suggested for his family.

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**Improving optometric industry employee’s knowledge sharing intention: human resource management practices**

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**Purpose:** The purpose of this study is to examine the association between human resource management (HRM) practices and knowledge sharing intention from the Taiwanese Optometric industry aspect.

**Methods:** The method of exploratory factor analysis to assess the reliability and validity of the statistical measurement model. The regression analysis method was applied to investigate the constructs relationships of the theoretical framework.
Results: Survey data gathered from 183 optometric employees in the Taiwanese optometric industry were used to test a motivational model of knowledge sharing intention related with HRM practice. The results show that expected extrinsic reward, organizational climate, teamwork, and knowledge sharing intention, indicate a significant relationship with human resource management practices, as cognitive by the managers in the Taiwanese Optometric industry.

Conclusions: The study conducted cross-sectional designs in providing causation evidence between the antecedents of knowledge sharing intention and HRM practices. Empirical findings from this research should be contribute for HRM managers in professional areas such as optometry industry, who planning strategies to develop an effective HRM practice competencies via applied knowledge sharing intention. The contribution of this research is the establish of a measurement system of knowledge sharing intention and HRM practices that could benefit future survey on human resource management, specialty highlighting critical implications for HR supervisor in Taiwanese Optometric industry.

Distribution of visual acuity in Korean adolescents by region

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Purpose: The study is to investigate the average visual acuity of Korean adolescents in 16 cities and provinces nationwide and to identify effectively the distribution and degree of visual acuity by region.

Methods: The study was designed to be a population based cross sectional study using data of the fourth and fifth sessions of the NHANES. The study was aimed at a total of 770 subjects aged 13-18, and their average age was 15.24±1.68 and the subjects were composed of 400 males and 370 females. The study divided the country into 16 cities and provinces, and calculated the average visual acuity according to each region. For visual acuity, the study proposed the uncorrected visual acuity of the left eye as a standard. Utilizing spatial analysis, the study used the GIS technique to demonstrate the distribution of visual acuity by region.

Results: The average visual acuity of the total subjects was 0.736±0.301, which was composed of 342 subjects (44.4%) with over 1.0 and 500 subjects (64.9%) with over 0.8. The average visual acuity of males and females was 0.772±0.281 and 0.697±0.317 respectively (p=0.001). For the 16 cities and provinces nationwide, the average visual acuity was 0.696±0.286 for Busan, 0.784±0.265 for Daeu, 0.786±0.302 for Incheon, 0.655±0.365 for Gwangju, 0.772±0.312 for Daejeon, 0.650±0.379 for Ulsan, 0.735±0.294 for Gyeonggi, 0.681±0.380 for Gangwon, 0.932±0.129 for Chungbuk, 0.761±0.285 for Chungham, 0.810±0.279 for Jeonbuk, 0.786±0.271 for Jeonnam, 0.738±0.309 for Gyeongbuk, 0.720±0.295 for Gyeongnam, and 0.596±0.311 for Jeju (p=0.016). In order to demonstrate the distribution of the eyesight of adolescents according to region, the study exhibited this with a picture utilizing a geostatistical analysis.

Discussion: The average visual acuity of Korean adolescents was 0.736±0.301 and showed differences by sex and region. The geostatistical analysis was effective in displaying the differences in visual acuity by region.
Relationship between indoor pollutants and eye symptoms at a newly built elementary school

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Purpose: The study aimed to evaluate the relationship between the concentration of environmental pollutants generated from a newly built building and children’s eye symptoms.

Methods: The study was aimed at 110 children at three schools, who attend classes at newly built elementary schools. Average age of the subjects were 12.93±0.32, and the group was composed of 54 boys (49.1%) and 56 girls (50.9%). For indoor air quality, the study collected samples of formaldehyde and volatile organic compounds, and analyzed them using HPLC and GC/MSD. A medical specialist confirmed their symptoms by diagnosing allergic rhinitis through a skin prick test (30 types). For eye symptoms, the study classified them into a group complaining about dry eye and a group without any complaints about dry eye.

Results: The average formaldehyde and benzene concentrations of each classroom were respectively 24.19 µg/m³ and 6.08 µg/m³ (class 1), 41.85 µg/m³ and 5.24 µg/m³ (class 2), 32.62 µg/m³ and 5.36 µg/m³ (class 3), 15.3 µg/m³ and 4.11 µg/m³ (class 4), and 13.67 µg/m³ and 4.25 µg/m³ (class 5). Also there were 57 students (51.8%) among the total subjects who were diagnosed to have allergic rhinitis and 60 students (54.5%) who complained about dry eye irritation symptoms. Among students who had allergic rhinitis symptoms, the ratio of students who complained about dry eye according to each classroom was 55.5%, 78.6%, 72.7%, 62.5%, and 66.7%.

Discussion: The formaldehyde and benzene concentrations of newly built elementary schools were measured to be 13.67 µg/m³ ~41.85 µg/m³ and 4.11 µg/m³ ~6.08 µg/m³ respectively, and eye irritation symptoms appeared in children studying in such environments. In particular, students who had allergic rhinitis complained more frequently about eye irritation symptoms such as dry eye.

Physical properties of hydrogel contact lens with type of Silicon-containing monomers

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Purpose: To examine the physical properties of hydrogel contact lens containing silicon-containing monomers such as 3-(trimethoxysilyl)propyl methacrylate (TRIM), 2-(trimethylsilyloxy)ethyl methacrylate (TEMA), (trimethylsilyl)methacrylate (TMMA).

Methods: Silicon hydrogel contact lens were prepared by the copolymerization (at 100 °C, 5 hrs) of a silicon-containing monomer, 2-hydroxyethyl methacrylate (HEMA), N-vinyl-2-pyrrolidone (NVP), ethylene glycol dimethacrylate (EGDMA) as a cross-linker, and 2,2’-azobisisobutyronitrile (AIBN) as a radical initiator in a cast mold.

Results: The water contents of silicon hydrogel contact lens were found to be 39.3%, 38.6%, and 36.4%, respectively, when the respective content of TRIM, TEMA, TMMA was 30% in the copolymers. The water content of hydrogel contact lens without silicon-containing monomer was 42%. The optical
transparencies of silicon hydrogel contact lens were determined to be 93%, 92%, and 79%, when the respective content of TRIM, TEMA, and TMMA was 30% in the copolymers.

**Discussion:** We think that the reason of low water contents of silicon hydrogel contact lens when compared with hydrogel contact lens without silicon is because silicon moiety has a hydrophobic property in the copolymer. TRIM-containing contact lens has a good optical transparency because strong Si-C bond in copolymer cannot be cleaved, resulting in no phase separation. TEMA-containing contact lens are also transparent because there is a little phase separation between –OH group and –O-Si(CH3) group in copolymer. The reason of opaqueness in TMMA-containing contact lens could be due to the phase separation between polar –COOH group and nonpolar –O-Si(CH3) group in copolymer.

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**Fitting characteristics and success rate of a daily disposable toric lens**

**Lin Song Chang¹, Chi Shing Fan²**

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**Purpose:** To investigate the fitting performance of a daily disposable (DD) toric contact lens (ocufilcon D 55%), and determine the empirical fitting success rate.

**Methods:** 29 astigmatic subjects participated in a daily wear, open label, bilateral dispensing study over 1 week. Evaluation of lens performance including VA, fit, rotation and lens stabilizing time at fitting visit. Lens was selected based on empirical fitting method. Eyes meeting the following criteria were classified as successful:

1. VA differences between CL and spectacle is 1.5 lines (decimal notation).
2. Lens stabilizes within 10 minutes or less.
3. Lens rotates less than 10° after 10 minutes of wear.
4. Lens movement rated as optimal or good.
5. Lens centration rated as excellent or good.

Subjects with both eyes successfully fitted rated overall lens performance using a 6-point Likert scale after 1 week of lens wear.

**Results:** At fitting visit, all 58 eyes achieved 0.8 VA (decimal notation, equivalent to 0.1 LogMAR) or better and had VA differences between CL and spectacle less than 1.5 lines; 93% of eyes had lens stabilized within 10 minutes; 95% of eyes had lens orientated within 10° after 10 minutes of wear; 100% of eyes had lens movement being rated as optimal or good; 97% of eyes had lens centration being rated as excellent or good. 25 subjects had both eyes meet all criteria resulting 86% empirical fitting success rate. 24 subjects with both eyes successfully fitted by empirical method rated overall lens performance as good or very good in all eyes at both visits by the investigator.

**Conclusion:** The ocufilcon D 55% DD toric lens demonstrated very good clinical performance and achieved a very high fitting success rate by using empirical fitting method.
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The performance of daily disposable etafilconA contact lens with moisture technology in subjects who report end of day contact lens dryness

Jack Chan, Kristy Canavan, Kathrine Osborn Lorenz
Johnson & Johnson Vision Care

Purpose: Contact lens (CL) dryness and discomfort continues to be a significant factor in patients’ dissatisfaction with CL wear. The purpose of this analysis was to evaluate the performance of Daily Disposable etafilconA contact lens with Moisture Technology in subjects who report end of day CL related dryness with their habitual contact lenses.

Methods: Using the data from a multi-site randomized, monadic one week dispensing clinical study, a post-hoc analysis was conducted on the subjects randomized to receive Daily Disposable etafilconA contact lens with Moisture Technology (test) who reported experiencing end of day dryness with their habitual lenses. Subjects were asked “How dry do your eyes feel at the end of the day when wearing your contact lenses?” at their enrollment visit. Those subjects who responded slightly, moderately, very or extremely dry were included. At the 1-week follow-up visit, subjects were asked questions on a 1-5 Likert scale.

Results: Eighty-two (82) of the 99 subjects assigned to wear the test lens reported end of day CL related dryness with their habitual lens at baseline. After wearing the test lens for 1-week, more than 70% of the subjects who reported having end of day dryness with their habitual CLs reported the test lens to be excellent/very good for the following attributes: Overall Comfort, Feeling fresh and new longer during the day, Comfort while working on the computer, Absence of irritation throughout the whole day, Vision not being foggy, cloudy or filmy, and Clarity of vision at the end of the day.

Conclusion: CL wearers continue to struggle with comfort and eye care practitioners need options to meet the needs of their patients. The majority of subjects, who had comfort complaints with their habitual reusable lenses, were highly satisfied with Daily Disposable etafilconA with Moisture Technology in a number of comfort and vision attributes.

Study on classification and test method of dry eye syndrome with workers in industrial workplace

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Purpose: The subject of this study is dry eye syndrome in workers in industrial workplaces which is rapidly increasing recently. This study classifies dry eye syndrome based on etiopathogenesis and its epidemiologic characteristics such as causal mechanism and symptoms. Each characteristic is analyzed by way of subjective test and objective test.

Methods: 4-level classification defined in DEWS has been used. Workers in industrial workplaces were asked whether they have eyeball irritation or not. They were asked to report its frequency by choosing one of; 1) none, 2) occasionally, 3) about half the time, 4) more than half, and, 5) mostly or always. They were also asked to report their eyeball symptom characteristics by choosing one of: 1) throb with pain, 2) feel being scraped, 3) feel dry, 4) feel prickly, 5) feel hot, 6) dazzling, 7) hazy sight, and, 8) poor eyesight. Existence of dry eye syndrome and the characteristics of its subjective symptoms were surveyed by McMonnies Questionnaire. In addition, objective test characteristics were studied by slit-lamp test, tear film break-up time test (BUT) and Schirmer test.
Results: Average age of test subjects was 29.52 years old and their average working hours per week was 39.73 hours. The result of objective tests on them was that; normal 17.9%, decrease in tear secretion 29.4%, decrease in tear film break-up time 20.1%, IgE increase 7%, hemoglobin increase 6% and eosinocyte increase 2.6%. The result of Schirmer test was that left side average 14.22mm and right side average 14.53mm. The tear film break-up test average was 10.023.

The result of subjective symptoms was that workers who feel their eyes dry were the most by 41.2%. Syndromes in higher frequency order were; feel prickly, hazy sight, dazzling, and poor eyesight, throb with pain, feel hot and feel being scraped.
The DEWS classification was that level 1 35.4%, level 2 47.5%, level 3 17.1% and level 4 0%.

Conclusion: The dry eye syndrome existence by objective test and by subjective test was compared. It is possible that a person who has dry eye syndrome by objective test does not feel the dry eye syndrome in subject test. Therefore, accurate prescription of dry eye syndrome and better classification Methods are required.

3
Comparison of McMonnies and ocular surface disease index questionnaires for dry eye screening test
Dong-Ki Oh
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Purpose and Methods: In this study, screening tests for dry eye were performed on university students in their 20s by using McMonnies Dry Eye Questionnaire (MDEQ) and Ocular Surface Disease Index (OSDI), and the prevalence was analyzed and compared. The study conducted a survey for the screening of dry eye (MDEQ and OSDI) on 1,157 students in the Department of Optometry at 10 universities in Korea.

Results: There was a significant correlation between the results of screening test for dry eye by the two surveys (r=0.85, p<0.01). The prevalence of dry eye by MDEQ was 23.1% when applying 10 points, 7.1% at 14.5 points, and 0.3% at 20 points. In addition, the prevalence of dry eye by OSDI questionnaire was 67.7% when applying 12 points, 41.6% at 22 points, and 19.2% at 33 points.

Discussion: This study compared the prevalence of dry eye by MDEQ and OSDI. As a result, when applying 10 points in MDEQ and 24 points in OSDI as a criterion for dry eye, the prevalence of dry eye was the most highly matched, 23.1% and 36.3%, respectively (k=0.62, p<0.01). 21.5% (249 students) of the subjects were equally diagnosed as dry eye in the two surveys.

4
Comparison of dry eye symptoms between welders and office workers
Ji-Kwang Ryu, Byoung-Sun Chu
Department of Optometry & Vision Science, Catholic University of Daegu, Korea

Purpose: To compare dry eye symptoms between welders and office workers using OSDI (Ocular Surface Disease Index) questionnaire.

Methods: Ocular Surface Disease Index questionnaires were distributed to 102 welders and 108 office workers who were all currently working in a ship-building company in Ulsan city, Korea. Demographic data collected included gender, age and length of working years in their current type of occupation. The mean age of welders was 42 ± 13.3 years old and it was 39 ± 10.5 for office workers. The mean length of working year for welders were 17± 9.4 years and 14 ± 7.8 for office workers.
Results: There were no statistically significant differences in age ($p=0.07$) and length of working years ($p=0.11$) between the two groups. There was no difference on dry eye OSDI score between welders and office workers ($t=-0.576$, $p>0.05$). OSDI score was significantly affected by the length of working years for welders ($p<0.05$), showing 0.44 increase of OSDI score by increasing year of working as a welder. However, there was no correlation between OSDI score and increasing working year for office workers ($p=0.6$).

Conclusion: This study demonstrated no difference of dry eye symptom between welders and office workers. This may be because each of the work environments has factors which may contribute to dry eye symptoms.

5
Tear volume and its distribution between RGP lens and cornea by corneal type and RGP lens design
Ji Hye Kim, Ki-il Kwon, Mijung Park, So Ra Kim
Department of Optometry, Seoul National University of Science and Technology, Seoul, Korea

Purpose: The difference in tear volume and its distribution between the RGP lens and the cornea was investigated by corneal types when the RGP lens with different designs was fitted.

Methods: 136 eyes were measured for corneal type using corneal topography and were classified into 5 types. The subjects were alignment fitted with RGP lenses according to the manufacturer’s fitting guideline. The alignment fitting status was determined by fluorescein staining and then fluorescein pattern was photographed by slit lamp camera. Tear volume and its distribution in central, mid-central, and peripheral regions were analyzed by fluorescein pattern of alignment fitting status using Quantity One software.

Results: The difference in tear volume and distribution was observed in all corneal types when spherical RGP lens was fitted. However, no difference of tear volumes was shown in the fitting of aspherical RGP lens, which were evenly distributed in round- and oval-typed corneas. The difference of tear volume was observed in round- and symmetric bowtie-typed corneas according to RGP lens design, however, significant differences were not observed in oval- and asymmetric bowtie-typed corneas. No difference was shown in relative tear volume on the peripheral region according to the corneal type in the fitting of both spherical and aspherical RGP lenses.

Conclusion: In this study, no difference in the tear volume of the same regions by corneal types was found when the same design of RGP lens was fitted. Therefore, these results found tear volume difference was caused by RGP lens design in the same corneal type rather than tear volume difference among corneal types. The results indicated RGP lens design showing the best alignment fitting status was different by corneal type. Therefore, suitable RGP lens design should be provided by corneal types.

6
Comparisons of tear volume and its distribution in spherical and aspherical RGP lens fitting by corneal eccentricity
Ji Hye Kim, Hyung Min Park, Ji Young Lee, So Ra Kim, Mijung Park
Department of Optometry, Seoul National University of Science and Technology, Seoul, Korea

Purpose: The difference in tear volume and its distribution between RGP lens and cornea was investigated by corneal eccentricity when spherical and aspherical RGP lenses were fitted in alignment.

Methods: 408 eyes having with-the-rule astigmatism were measured for corneal eccentricity by corneal topography and their corneal eccentricity was classified into five ranges based on an average
eccentricity of 0.53 by the range of 0.1. Among them, 136 eyes were fitted with RGP lens and then fluorescein pattern was photographed with a slit lamp camera and converted to computer files. Tear volume and its distribution were analyzed using Quantity One software after the fluorescein pattern was divided into central, mid-central, and peripheral regions.

Results: The difference in tear volume was observed in corneal eccentricity of 0.38≤e<0.68 and its difference was largely observed between the peripheral and other regions when spherical RGP lens was fitted. Tear distribution was even with spherical RGP lens except 0.38≤e<0.68. The mid-central tear volume on cornea having the eccentricity of e≥0.68 was more than peripheral tear volume when aspherical RGP lens was fitted. Tear distribution was even in corneal eccentricity of e<0.48 without difference in tear volume caused by lens design. Tear distribution on cornea having the eccentricity of 0.48≤e<0.68 was more evenly distributed when aspherical RGP lens was fitted. However, tear distribution on cornea with an eccentricity of e≥0.68 was more evenly distributed when spherical RGP lens was fitted. Positive correlation was shown between corneal eccentricity and peripheral tear volume when spherical and aspherical RGP lenses were fitted, and aspherical RGP lens was more affected by corneal eccentricity.

Conclusion: The difference in tear volume and its distribution was affected by corneal eccentricity and RGP lens design. Therefore, RGP lens fitting should consider both corneal eccentricity and RGP lens design.

7
Contact lens prescribing pattern in Korea during 2010 to 2012
Jong-Ha Lee1, In-Jee Park2, Byoung-Sun Chu1
1Department of Optometry & Vision Science, Catholic University of Daegu, 2Department of Optometry & Vision Science, Kaya University, Korea

Purpose: To understand the pattern of prescribing contact lenses in Korea during 2010 to 2012.

Methods: Three hundred survey questionnaires were randomly posted to Korean Optometric clinics for 3 years. The questionnaire was the same form used for International Contact Lens Prescribing Trend and designed to collect information about the contact lenses prescribed to the first 10 patients after its receipt.

Results: Among the three hundred survey questionnaires, 172 questionnaires were returned providing data regarding 1567 fits. The mean age at fitting was 26.2±7.0 in 2010, 26.1±7.6 in 2011 and 24.7±6.6 in 2012. The majority of fits were female patients (75%). Rigid Gas Permeable Lenses (RGP) accounted for 9% of the fits while 91% were of soft contact lenses. Amongst the soft contact lenses, low water content accounted for 26% of fits, 45% were mid water content fits, high water content accounted for 16% of fits, and silicon hydrogel lenses were 17% of fits. Sixty six percent of the soft lenses fits were of spherical contact lenses while 13% were of toric design, and cosmetic contact lens accounted for 20% (15% in 2010, 20% in 2011, and 40% in 2012). Multifocal contact lenses were prescribed only 1%. In terms of replacement schedule, the majority of the soft contact lens fits were 3~6-month replacement (45%). The daily disposable lenses accounted for 31%. Ninety seven percent of lens care solution was multi-purpose solution.

Conclusion: The majority of the contact lenses wearers were female and mean age become slightly younger. In relation to increase of younger female contact lens wearer, cosmetic lenses prescribed were much higher (20%) than global mean (1%) for last 3 years. This trend could be related to the growth of beauty market in Korea.
Prescribing trend of beauty contact lens in Hong Kong
Benny Bing-Tin Tam, Karen Cheng
Johnson & Johnson Vision Care Hong Kong, Hong Kong SAR, China

**Purpose:** To understand the prescribing trend of beauty contact lens in Hong Kong.

**Methods:** An online survey of contact lens wear was conducted between April 2011 to March 2013. Three thousand six hundreds Hong Kong citizens (aged 15-39) were asked to provide their contact lens wear information, including type (beauty/ clear, limbal ring/ colour) and modality of contact lens (daily, biweekly, monthly, conventional). Incidence trend was shown and compared by quarterly rolling 12-month periods.

**Results:** Prescribing trend of toric lens increased with more than 85% from rolling 12-month at Q1 2012 to Q1 2013. Among the beauty lens wearers, the limbal ring lens wearers was increased from 68% in Q1 2012 to 77% in Q1 2013 and the colour lens wearers was reduced from 31% in Q1 2012 to 23% in Q1 2013. Distribution of the modality of beauty lens among daily disposable, 2-week disposable, monthly disposable and conventional were changed from 51%, 10%, 18% and 20% in Q1 2012 to 70%, 3%, 16% and 12% in Q1 2013 respectively.

**Conclusion:** These findings showed the significantly growing trend of beauty contact lens in Hong Kong with the increase of distribution of limbal ring lens in type and daily disposable in modality.

9
Optometry and contact lens practice patterns among Indian optometrists - a pilot study
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International Association of Contact Lens Educators (IACLE), Bharati Vidyapeeth School of Optometry, Pune, India

**Purpose:** The scope of optometry practice and range of clinical services offered by optometrists in India are not well documented. Hence, a pilot study with Bharati Vidyapeeth (BVP) optometry alumni in India was conducted to understand the practice patterns among Indian Optometrists.

**Methods:** A validated online survey was distributed to 165 optometry alumni of BVP. The survey collected demographic details, range of clinical services offered and mode of practice. Details regarding Contact Lens (CL) services, lens types and modality of wear were also included.

**Results:** Responses of 70 optometrists from 27 cities were received. One third of the total respondents were working in more than one mode of practice. Working in optical retail (25%), owning optical practice (23%), corporate optometry (16%) and academia (13%) were the top four modes of practice. Clinical services were provided by 76% of optometrists. Routine examinations (66%), optical dispensing (59%), CL (56%) were the top three clinical services provided. CL patients contributed to 30% of total patients. Fifty four percent of CL fits were described as 'new' fits. Toric lenses contributed to 29% of fits. 45% and 5% of patients were prescribed silicone hydrogels (SH) and RGP lenses, respectively. By replacement schedule, 10 % were conventional, 64% were monthly disposable and 12% were daily disposable lenses.

**Conclusions:** The study provided valuable insights on the pattern and scope of optometry of BVP alumni. Contact lens is a large part of clinical practice in India. Disposable modality dominated CL practice. The proportion of toric lens fits was at par with the global and much higher than other Asian figures. Compared to other Asian countries, SH contributed much higher percentage of fits.
Contact lens prescribing trend in Korea in 2012
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Purpose: Survey questionnaires were randomly mailed to Korean Eye Care Practitioners (ECPs) in 2012 to study the latest trend of contact lens prescription, contact lens examination and fitting in Korean ECPs.

Methods: A survey was conducted on randomly selected 150 ECPs from optical stores in Seoul, Kyunggido, Busan, Daejun, Daegu and Gwangju. The survey consisted of 11 contact lens fitting related questions, 5 contact lens fitting test related questions, 10 contact lens care and complication related questions.

Results: Fitting of Soft clear contact lenses accounted for 60.19% of the fits, beauty contact lenses 33.93% of the fits, while RGP lenses 6.03% of the fits. For Soft clear contact lenses, 88% were of spherical design, 11% toric design and 0% multifocal design. For RGP lens, 4% was spherical design while 93% was aspherical design. Amongst the soft contact lenses replacement schedule, the daily disposable contact lens accounted for 37% of fits, the monthly disposable contact lens accounted for 29% of fits, the conventional contact lens accounted for 22% of fits. Preferred examinations by the ECPs after soft lens fitting were subjective comfort of the wearers 51%, centration 27% and push-up test 19% and for the RGP lens fitting were subjective wearer’ comfort 36%, centration 35%. After fitting toric contact lens, 58% of the ECPs pursuit autorefraction and 18% of them pursuit over-refraction for the assessment. It was found that more than 90% of ECPs “always or often” explain on contact lens care and complications for patients.

Conclusions: This survey study that Korean ECPs have a tendency to fit spherical and beauty contact lenses actively, while toric contact lenses were fitted less frequently and multifocal contact lenses were fitted rarely, may be extensive toric and multifocal contact lens fitting training are needed. Many Korean ECPs evaluate comfort as the criterion of ideal fitting; more training for the evaluation of optimal contact lens fitting is needed.

Survey of patient and practitioner satisfaction when refit with silicone hydrogel contact lenses from hema contact lenses
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Purpose: To determine patient satisfaction when refit from low Dk/t Hema contact lens to a high Dk/t Silicone Hydrogel (SiHy) contact lens.

Methods: 10 eye care practitioners (ECP) participated by refitting and surveying 10 current Hema lens wearers with a SiHy lens then completed a satisfaction survey. Each eligible Hema wearer was fitted with SiHy (Lotrafilcon B) lenses and provided a 300ml bottle of lens care (PolyQuad, Aldox and Hydraglyde). An 8 question survey using a 5 point Likert scale was completed at the first fitting visit concerning satisfaction with Hema lenses then 4 weeks after wearing the SiHy lenses. The data collected included subjective assessment including overall vision, end of day dryness, overall comfort and end of day dryness. Overall wearing time was also recorded. At the completion of the survey period, each ECP was surveyed for their continued use of SiHy lenses.
Results: A total of 89 wearers with mean age 29 years completed the surveys. The average wearing time increased by 1 hour per day (9 to 10 hours) and average number of days wearing lenses increased by 1 day (5 to 6 days) after being fitted with the SiHy lens and lens care combination. For all 8 questions, a significant increase in their agreement with the statement was determined. This included vision, comfort at end of the day and less end of day dryness. At the conclusion of survey, 94% of wearers preferred the SiHy lens and lens care combination compared to their previous Hema lenses.

Conclusion: The use of the SiHy and lens care combination increases overall wearer satisfaction with greater wearing time during the day and number of days able to be worn. The survey confirms wearers have a better lens wearing experience compared to the older technology Hema contact lenses.

Factors affecting intraocular pressure after corneal refractive surgery
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Purpose: To investigate the significant parameters that affect intraocular pressure (IOP) measured by non-contact tonometry in patients who have undergone corneal refractive surgery.

Methods: One hundred fifty four subjects who underwent Laser in Situ Keratomileusis (LASIK) or Laser assisted sub-epithelial keratomileusis (LASEK) participated in this study. IOPs were measured with non-contact tonometer (KT-800, KOWA, JAPAN) and corneal curvature, corneal ablation amount and central corneal thickness measurement were performed by using Orbscan topography (Orbscan II, Busch + Lomb, USA). A paired Student’s t-test, one-way ANOVA test, correlation analysis and regression analysis were conducted for the analysis.

Results: The subjects who received corneal refractive surgery were in the mean age of 31.45 ± 5.98 years and 83 patients (131 eyes) were in LASIK group and 71 patients (130 eyes) were in LASEK group. The average spherical equivalent power, preoperative central corneal thickness, and preoperative IOP were -5.68±1.96 diopters, 564.58±28.94 μm, and 13.66±2.55 mmHg, respectively. The post-operative IOPs were decreased over the periods of operation in both of the LASIK and LASEK groups. IOPs beyond 3 months of recovery time, there was no difference between types of surgery. The correlation between central corneal thickness and IOP before and after surgery were able to confirm that the thicker central corneal thickness and higher IOPs. There was no correlation between corneal astigmatism and IOPs. The changes of IOP had a positive correlation with the amount of corneal ablation and corrected diopter and changes of the corneal curvature. The underestimated IOP per 1 diopter correction was 0.41 mmHg (R=0.334, p<0.05).

Conclusions: The IOP measured with non-contact tonometer after refractive surgery decreased and the amount of underestimated IOP were increased with the amounts of corneal ablation and changes of the corneal curvature, this needs to be noted for possible abnormality for the screening of glaucoma in such patients.

Effect of longer light cycle and higher lighting illumination on mouse intraocular pressure
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Purpose: To investigate the magnitude, and dynamic pattern of intraocular pressure (IOP), and to clarify the effect of light cycle and illumination on IOP in a mouse model.

Methods: ICR mice were randomly divided into 3 groups: (1) mice were exposed to a 12-hour light/dark cycle under 50 lux of lighting illumination; (2) mice were exposed to a 12-hour light/dark cycle under 1000 lux of lighting illumination, (3) mice were exposed to a 24-hour light cycle under 5000 lux of lighting illumination. The exposure period was 15 days for every group. IOP was measured at days 0, 3, 5, 7, 10, and 15 using a micro-needle method.

Results: The mean IOP of mice that were exposed to a 24-hour light cycle under 5000 lux of lighting illumination was 13.3 +/- 2.0 mm Hg at day15 (n=12), which was higher than those exposed to a 12-hour light/dark cycle under 50 lux of lighting illumination (10.0 +/- 0.4 mm Hg at day15, n=9), and those exposed to a 12-hour light/dark cycle under 1000 lux of lighting illumination (10.5 +/- 0.7 mm Hg at day15, n=9). The fluctuation of IOP was also higher under the influence of longer light cycle and higher lighting illumination.

Discussion: This result showed that longer light cycle and higher lighting illumination can cause higher intraocular pressure on a short-term basis.

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Study on balance direction in homonymous hemianopia
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Purpose: Walking toward the intact visual field direction for people with homonymous hemianopia tends to be corrected after they realize that they were walking in the wrong direction. This led us to ask whether the adapted direction is able to be quantitatively described and alternative vision is helpful to avoid diplopia due to Fresnel prism.

Methods: One homonymous left hemianopic patient participated. Eleven people with normal visual field took part in simulation for right hemianopia. To prevent participants from correcting their direction with the surrounding environment, they were requested to fixate the distance at 3~4m while walking in a field. The changed angle between pre- and post- 40 prism segment prescription was measured and 2 photos taken at starting point to walk and ending point were superimposed. A manipulated mini fan was utilized to block diplopia caused by Fresnel prism.

Results: The left hemianopic patient walked toward the left side in deviation of 37 degrees after the prescription. Nine of eleven participants for right hemianopic simulation walked toward 11.9 degrees in intact left side before the prescription. On the other hand, eight of eleven participants walked toward defected but extended right side in deviation of 19 degrees after the prescription of Fresnel prism.

Conclusions: Hemianopic patients learn through trial and error on how to walk straight. From the stage that they learned to walk correctly, their perception about the direction is no longer balanced. Therefore, it is important to explain to them about the shifted balance in direction and guide them through safety walking procedures during rehabilitation. There was subjectively good response with alternative vision after prescription despite statistically non-significant results.
Correlation between central corneal thickness and corneal endothelial cell density in subjects with diabetes mellitus

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**Purpose:** To evaluate central corneal thickness (CCT) and corneal endothelial cell density (ECD) in diabetics compared with age-matched, healthy subjects.

**Methods:** This was an observation study which was conducted using Pentacam pachymetry and noncontact specular microscopy. Individuals’ age between 40-60 years having type II diabetes for at least 1 year was included in the study. Patients with any corneal abnormalities, ocular diseases, corneal or lenticular or retinal laser treatment, any neurological surgery, and any medications that are known to affect corneal endothelial cell density and/or corneal thickness were excluded from the study. All recorded values were compared with age and gender matched individuals for final analysis.

**Results:** 60 subjects had equal gender distribution and 30 subjects were selected in each diabetics and control group. The mean age of diabetics and control group was 51.92 ± 5.57 yrs and 49.63 ± 6.59yrs respectively. The mean duration of diabetes was (4.63 ± 2.7yrs). Statistical analysis was carried out using t-test with the significance level of 0.05. ECD in normal subjects was 2555.43 +/- 10.56cell/mm² and CCT was 519.91 +/- 2.40mm, while the mean ECD in diabetics was 2548.08 +/- 42.69cell/mm² and CCT was 536.46 +/- 0.35mm. It showed little statistically significant difference in CCT (p=0.0049) and ECD (p=0.9122) between the diabetics and aged matched normal. It also showed positive correlation (p<0.05) in CCT and negative correlation (p<0.05) in ECD with increase in duration of diabetes.

**Discussion:** The study shows patients with diabetes have thicker central corneas and decreased endothelial cell densities as compared with healthy normal subjects, although we could not conclude if only duration of diabetes affected the CCT and ECD.

Detecting tear glucose concentration using point-of-care diagnostic technique

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**Purpose:** As a non-invasive point-of-care diagnostics, paper based microfluidic devices were applied to detect tear glucose concentration.

**Methods:** Quantitative colorimetric results of glucose concentrations were demonstrated by using glucose oxidase and staining solution (DEPDA, 4CN, H2O2). Liquid samples with varying concentration of glucose solution and human tears were directly deposited on paper based microfluidic devices.

**Results:** With increasing glucose intake, paper based microfluidics showed increased levels of tear glucose concentrations. Tear glucose concentrations were continuously amplified for 45 min. after glucose intake. However, after 45 min., the concentrations were decreased and back to ground condition after an hour.

**Conclusion:** The non-invasive paper based microfluidic devices were user friendly and able to exhibit tear glucose concentrations with small amount of samples.
Beneficial or detrimental? The ChromaGen 1 lens system effects on congenital colour vision defects
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Purpose: To determine the ChromaGen 1 lens system effects on congenital colour vision defective (CVD) patients as tested with the Ishihara and the D-15 tests.

Methods: Ten male CVD subjects (three deuteranomalous, five deuteranope and two protanope subjects) were identified and diagnosed by the Nagel anomaloscope. The suitable ChromaGen 1 lenses were selected according to subjects' subjective responses. Colour vision performance on the Ishihara and the D-15 tests, as well as visual acuity and contrast sensitivity, were performed with and without the ChromaGen 1 lenses.

Results: All but one subject preferred to wear the ChromaGen lenses binocularly with 90% of them selecting magenta-coloured ChromaGen lens as the most preferred lens to wear. At baseline, all deuteranope and protanope subjects failed both the Ishihara and the D-15 tests, while deuteranomalous subjects failed the Ishihara test only. Overall performance after wearing the ChromaGen 1 lenses showed a significant decrease in error rates in both colour vision tests, especially for the deuteranomalous subjects. Quantitative scoring analysis (total error score (TES), total colour differences score (TCDS), confusion index (CI) and selective index (SI)) using the D-15 revealed significant reduction in the parameters measured for deuteranopes (Wilcoxon Signed Rank Test, p<0.05). Although the error rates were reduced for the deuteranomalous and protanopes, the changes are not significant. Visual acuity and contrast sensitivity tests performed also showed non-significant differences before and after the ChromaGen 1 lens wear.

Conclusions: The findings showed that deutan subjects benefit more from using the ChromaGen 1 lens, compared to protan subjects. However, the results should be interpreted with caution due to the small sample size on each CVD groups.

The study of age-related macular degeneration in an adult Korea population
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Purpose: This study was performed to assess the prevalence and risk factors of age-related macular degeneration

Methods: The prevalence and risk factors of AMD were investigated based on data of the National Health and Nutrition Examination Survey. Participants of KNHNES were over 40-years old group (3,700 people, aphakia exception). Macular degeneration was observed by Nonmydriatic Fundus Camera.

Results: The AMD prevalence was an estimated 9.4% (men: 3.8%, women: 5.6%). Early AMD was observed in 320 patients (8.6%) and 29 patients (0.8%) had late AMD. Dry type was observed in 8 patients (0.2%) and 22 patients (0.6%) had wet type. The Early AMD was significant correlation with Age (r=0.205, p=0.000), smoking (r=0.041, p=0.013), hypertension (r=0.065, p=0.000), degree of obesity (r=-0.039, p=0.017), uv exposure time (0.061, p=0.000). The late AMD was significant correlation with Age (r=0.076, p=0.000), hypertension (r=0.039, p=0.016).

Discussion: In the Korean population aged 40 years or above, prevalence of AMD was 9.4%. Age, smoking, hypertension, degree of obesity, UV exposure time significantly increased the risk of the AMD.
These results are important for identifying vision health issues in Korea and to establish proper health care policy for eye diseases.

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**Macular pigment optical density in a healthy Sri Lankan population**

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**Purpose:** Macular pigments protect the retina against age related macular degeneration, by its ability to absorb blue light and scavenge free radicals. Current information on human macular pigment density is largely from studies on Caucasian populations. The purpose of this study was to assess macular pigment density in a Sri Lankan population.

**Methods:** Macular pigment optical density (mpod) was measured in 265 healthy Sri Lankans using Visucam 500 fundus camera. Participants underwent a standard ophthalmic examination and only those who were confirmed not to have any eye diseases were included in this study.

**Results:** A total of 265 unrelated Sri Lankans including 132 males and 133 females aged from 10 to 90 years participated in the study. The mean mpod level was 0.14, females were found to have relatively lower mpod than males.

**Conclusion:** Macular pigment optical density in this healthy Sri Lankan population sample varied with age; 10-40 age group showed lower mpod, 40-70 highest mpod level and then decline with the age. Females have lower macular pigment levels than males.

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**Comparison of corneal configuration measurements with 2 Scheimpflug imaging devices**

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**Purpose:** To assess the reproducibility and comparability of corneal configuration measurements using GalileiTM (dual-Scheimpflug system) and Pentacam® (single-Scheimpflug system).

**Methods:** Twenty-one eyes of 21 healthy subjects (mean age: 22.8 ± 2.8 years, range: 21 to 34 years) were recruited. Corneal curvatures (CR), anterior and posterior eccentricity (Q=-e²), central corneal thickness (CCT) were measured with GalileiTM (Ziemer Ophthalmic Systems, Port, Switzerland) and Pentacam® (Oculus, Wetzlar, Germany). Bland-Altman plots (i.e. mean difference and 95% limits of agreement [LOA]) were used to evaluate the reproducibility and the comparability in the measurements between two imaging devises.

**Results:** The mean CR, anterior eccentricity, posterior eccentricity, and CCT were 7.72 ± 0.24mm, 0.32 ± 0.16, 0.50 ± 0.24, 556.31 ± 21.06μm for dual-Scheimpflug system and 7.70 ± 0.24mm, 0.33 ± 0.21, 0.01 ± 0.21, 554.52 ± 28.16μm for single-Scheimpflug system. The dual-system had significantly higher posterior eccentricity than the single-system (p < 0.0001). There was no statistically significant difference in mean CR, anterior eccentricity and CCT between two devices.

**Conclusions:** Both devices with Scheimpflug imaging system provided high reproducibility and comparability of corneal configuration measurements.
Spatial and temporal summation in peripheral retina
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Purpose: People with macular degeneration use peripheral retina to see objects because of central scotoma. In order to make a guide line for eccentric viewing training, spatial and temporal summations in peripheral retina were measured.

Methods: Twenty subjects wearing spectacles and ten subjects wearing soft contact lenses took part. Visual stimuli were generated by a psychophysical measurement software program Morphonome. Contrast sensitivity (CS) was measured with a two-alternative forced choice staircase for 0.7 and 3 cpd sinusoidal grating stimuli of duration 16-1216ms and circular spatial extent ranging from 2-10 degrees at the eccentricity of 20 degrees on the right eye. Temporal and spatial functions were plotted and the saturation point (duration or degrees at which CS no longer increased) was determined.

Results: The shapes of the functions for 0.7 cpd were similar to those of 3.0 cpd, but shifted upwards because of CS increase. The critical durations were 540 and 315 ms for 0.7 and 3.0 cpd respectively, while critical size for 0.7 cpd was 6 degrees but the one for 3.0 cpd was not determined because CS kept going up. The longest critical duration was 766 ms for subjects with spectacles for 0.7 cpd, while the shortest critical duration was 130 ms for subjects with contact lenses for 3.0 cpd. The largest difference for critical size was 1.3 degrees for 3.0 cpd.

Conclusion: CS was increased longer for lower spatial frequency than higher one, as target exposure became longer, while CS for higher frequency was continuously going up as target size was greater. Therefore, it will be more effective to use big print books with enough time for eccentric viewing training.

The correlation between total high order aberrations and age when analyzed by the degree of refractive error
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Purpose: The present study was performed to investigate the correlation between the age and total higher order aberrations (HOAs) when analyzed by the degree of refractive error.

Methods: 649 eyes (mean age of 35.1 ± 8.8 years; range 20~62 years) having astigmatism lower than -1 cyl. D were divided into three groups based on the myopic degree; 1) low myopic group (233 eyes with less than -3 D); moderate myopic group (348 eyes between -3 to -6 D); and high myopic group (98 eyes with more than -6 D). Then, their total HOAs were measured by using the LADAR WAVE (Alcon LADARWave®️, Texas) and analyzed by the age.

Results: Coma aberration significantly decreased with age in the low myopic group (r=-0.166, p=0.011) and the moderate myopic group (r=-0.131, p=0.015). However, spherical aberration tended to increase according to increasing age in the low myopic group (r=0.087, p=0.186). Significant decrease of spherical aberration with increasing age was only shown in moderate myopic group (r=-0.136, p=0.011), and not in high myopic group (r=-0.157, p=0.122).

Conclusion: It is found that coma aberration is not affected by the degree of refractive error and decreases with age. However, spherical aberration is affected by the degree of refractive error unlike coma aberration.
Influence of cycloplegia on higher order aberrations in emmetropia under scotopic condition

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Purpose: To investigate the influence of cycloplegia on higher-order aberrations (HOAs) of the emmetropic eye under scotopic condition.

Methods: Forty eyes of 20 subjects in their twenties (21.0 ± 2.6 years; 10 females, 10 males) with emmetropia were enrolled. The subjects’ criteria were best unaided monocular visual acuity of 20/20 or better. High (100%) and low (10%) contrast logMAR visual acuities were measured under photopic and mesopic conditions. Ocular HOAs were measured for 4-mm and 6-mm pupils, using Wavefront Analyzer (KR-1W, Topcon, Japan) under scotopic condition before and after cycloplegia with topical installation of 1% tropicamide and 1% cyclopentolate. All measurements were compared before and after cycloplegia.

Results: Pupil size was 6.08 ± 0.76 in natural scotopic condition and 7.78 ± 0.30 in cycloplegic scotopic condition. A small but statistically significant difference was found between natural scotopic (0.038 ± 0.000) and cycloplegic (0.045 ± 0.000) conditions for spherical aberration (p=0.046) with a 4-mm pupil. However, for ocular HOAs, there were no significant differences in total HOAs, third-order, fourth-order, coma, and spherical aberration for a 6-mm pupil between two conditions.

Discussion: Our results did not find the effect of cycloplegia on HOAs. Ocular HOAs in the wavefront aberration measurement may not be directly affected by accommodation in emmetropia.

The correlation between total high order aberrations and age when analyzed by the pupil size

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Purpose: The present study was performed to investigate the correlation between age and total higher order aberrations (HOAs) when analyzed by the pupil-sizes during scotopic vision.

Methods: 735 eyes (mean age of 34.9 ± 9.0 years; range 20~62 years) were divided into three groups based on the myopic and astigmatic degrees; low-refractive error group (159 eyes with myopia of D< -3 and astigmatism of D< -1), moderate-refractive error group (129 eyes with myopia of -3≤D< -6 and astigmatism of -1≤D< -2), and high-refractive error group (447 eyes with myopia of D≥ -6, astigmatism of D≥ -2). Then, their total HOAs were measured by using the LADAR WAVE (Alcon LADARWave®, Texas) and analyzed by the pupil sizes of 4.2 ~ 6.5 mm and 6.5 ~ 9.0 mm during scotopic vision.

Results: In the group of pupil size smaller than 6.5mm, coma aberration significantly decreased with age in low-refractive error(r=-0.144, p=0.003) and high-refractive error(r=-0.185, p=0.027) groups but not in moderate refractive error group. The group of pupil size larger than 6.5mm, coma aberration significantly increased with age only in the low-refractive error group(r=-0.217, p=0.022) not in the moderate-refractive error(r=-0.113, p=0.309) and the high-refractive error (r=-0.023, p=0.656) groups. In the group of pupil size smaller than 6.5mm, spherical aberration tended to decrease with the age in all refractive error groups while the spherical aberration in other pupil-sized group tended to increase with the age in low- and moderate-refractive error groups.
**Conclusion:** It suggests that the change in coma aberration with the age is affected by both of the degree of refractive error and the pupil size during scotopic vision since coma aberration significantly decreased with the age when the degree of refractive error and pupil size were small in our study.

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**UV-blocking contact lenses can significantly prevent UVB-induced corneal inflammation and anterior segment uveitis**

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**Purpose:** UV-absorbing contact lens has been regarded as having beneficial effects in preventing eye diseases related to UV exposure. This study investigated the bioprotective effects of several daily disposable soft contact lenses against UVB-induced corneal inflammation and anterior segment uveitis in a mouse model.

**Methods:** The mice were randomly divided into 5 groups: (1) blank control, (2) exposed to UVB without contact lens protection, (3) exposed to UVB and protected with Nelfilcon A contact lenses, (4) exposed to UVB and protected with Filcon A contact lenses, (5) exposed to UVB and protected with Etafilcon A contact lenses. After UVB radiation, the eyeball specimens were processed for ocular surface assessment and microscopic analysis of corneal epithelial cell populations and inflammatory markers.

**Results:** The results showed impaired corneal surface with polymorphonuclear leukocyte infiltration into the stroma and anterior chamber after UVB exposure, in contrast to the intact status of the blank controls. The corneas covered with Filcon A and Etafilcon A contact lenses maintained more cells positive for P63 and PCNA, as compared to those with Nelfilcon A or without contact lens protection. Furthermore, the anterior segment contained less PMN infiltration and less induction of proinflammatory factors, including nuclear factor-kappa (p65), cyclooxygenase-2, Fas and MMP-9, when protected by Filcon A and Etafilcon A.

**Discussion:** This study demonstrated various protective effects of daily disposable contact lenses against UVB-induced ocular surface inflammation and anterior segment uveitis. The mouse model used in the present study may be used extensively for in vivo assessment of UV shield efficacy.

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**Dietary intake of chrysanthemum morifolium flower extracts can ameliorate UVB-induced ocular surface damages**

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Purpose: Short-term damages to the ocular surface caused by UV irradiation may be subtle and easily ignored. However, long term UV irradiation poses a critical threat to ocular surface health and may cause dry eye symptoms, which cannot be ignored. This study investigated the preventive effects of Chrysanthemum morifolium flower extracts (Cmfe) against UVB-induced ocular surface degeneration and dry eye.

Methods: ICR mice were randomly divided into 14 groups: (1) blank control, (2) with UVB exposure but without Cmfe, (3-5) with UVB exposure and with 3 different doses of ethanol-extracted Cmfe from yellow flowers, (6-8) with UVB exposure and with 3 different doses of ethanol-extracted Cmfe from white flowers, (9-11) with UVB exposure and with 3 different doses of water-extracted Cmfe from yellow flowers, (12-14) with UVB exposure and with 3 different doses water-extracted Cmfe from white flowers. All groups were subjected to corneal surface evaluations; including smoothness, opacity, and extent of staining, tears production, together with PAS staining, in order to determine the UVB-induced ocular surface injury, with or without various Cmfe treatments.

Results: The results showed that chrysanthemum morifolium flower extracts were effective in the prevention of UVB-induced conjunctival damages in a dose-dependent manner. Regardless of extraction from yellow or white flowers and be it ethanol-extracted or water-extracted, Cmfe can effectively reduce UVB-induced ocular surface degeneration and dry eye from 100 mg/kg.

Discussion: Dietary supplementation of chrysanthemum morifolium flower extracts can ameliorate UVB-induced ocular surface damages and conjunctival damages by maintenance of goblet cell number and tear quality. Further analysis of the underlying mechanism will be helpful for the promotion of chrysanthemum morifolium flower extracts in clinical practice.

Evaluation of in vivo protective efficacy of RGP contact lenses against ultraviolet B irradiation

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Purpose: UV irradiation causes a variety of ocular diseases. Particularly, the short wave UV at 312 nm wavelength inflicts most on corneal health after long term exposure. Previous animal studies have been focused on the protective effects by soft contact lenses and relatively few evaluations on rigid gas-permeable (RGP) lenses were reported. Hence, this study investigated the protective efficacy of RGP contact lenses against UVB irradiation under in vivo conditions in the mouse model.

Methods: ICR mice were randomly divided into 4 groups: (1) blank control without UVB exposure, (2) with UVB exposure, (3) with UVB exposure, and with TMVC RGP, and (4) with UVB exposure, and with Sinsaki RGP. Following anesthesia, the mice of groups (3) and (4) were covered with RGP lenses and exposed to daily UVB for a 5-day period. Visual acuity was assessed, followed by cornea surface assessment for smoothness, opacity, and grading of lissamine green staining. The eyeball specimens were processed for H-E staining and immunohistochemistry detection for corneal epithelial cell populations and inflammatory markers.

Results: UVB exposure lead to corneal surface damages, including reduced smoothness and transparency, impaired cornea sensitivity and visual acuity. Histological analysis revealed that corneal thickness was decreased and fewer p63+ basal cells were observed. Immunohistochemistry assay
showed altered expression of COX-2, NF-κB, Fas, MMP-9 and Cytokeratin-5. With TMVC or Sinsaki RGP lenses to shield UVB irradiation, the tissue damages and the alterations of cellular and inflammatory markers were all ameliorated.

**Discussion:** This study demonstrated the bio-protective effects of RGP by using mouse as a study model for the assessment of UV shield efficacy. The current mouse model may be used widely for this kind of evaluation under in vivo conditions.

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**Visual health care for senile cataract patients - comparison between subjective and objective optometry tests**

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**Objective:** Senile cataract is an ocular lens degenerated disease affecting old people. Blurred vision is the main symptom for people with senile cataract. Blurred vision affected not only life quality but also safety in daily life. This study compared the corrected visual acuity between subjective and objective optometry tests.

**Material and Methods:** Cataract patients are collected at a medical center in central Taiwan. Only people aged more than 55 years old are included. People with other eye diseases except cataract are excluded. Corrected visual acuity for objective and subjective optometry tests are obtained for each patient by the same two optometrists. Descriptive and inferential statistics (Bland-Altman plot) are performed by SPSS version 18.0.

**Results:** Forty four patients are included (so far) and at least 90% patients were selected to enter the final calculation after thoroughly complete ocular checkups. The results are shown that there are no statistical differences between corrected visual acuity for objective and subjective optometry tests (p<0.05).

**Discussions and Conclusion:** Previous studies had pointed out that subjective optometry test is the standard for refractive error examinations. But objective optometry test is less time consuming. There were studies investigating the differences between objective and subjective optometry tests, and the results are shown that there are no differences between the two kinds of tests. However, the previous studies only focused on refractive status but not on corrected visual acuity. This study investigating corrected visual acuity suggests that objective optometry test is a choice for senile cataract patients.

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**Changes of binocular function after refractive surgery**

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**Purpose:** Myopic refractive surgery patients who received preoperative amplitude of accommodation, phoria degree, binocular stereopsis, and functional changes were followed for 3 months.

**Methods:** 50 people (23 males, 27 females) in their 20's were enrolled. They were monitored before and after myopic refractive surgery (1week, 1month, 3months) using the amplitude of accommodation
test (Push-up method), the phoria test of far and near (Howell by chart for 3m, 33cm test), and stereo-acuity test (Tiltnus stereopsis chart).

**Results:** Mean Refraction before refractive surgery was -4.96±2.17D, mean refraction was -0.54±0.44D three months after surgery. Accommodation before refractive surgery was 9.85±2.29D, after surgery, 1 week, 1 month and 3 months accommodations were 7.85±2.05D, 7.99±1.81D, and 9.16±2.01D respectively. A week after surgery accommodation fell but increased again after three months (F=21.83, p<0.001). The far phoria before refractive surgery were -0.03±1.96△, three months after surgery the far phoria was measured to be 0.15±1.96△, also the near phoria before surgery ranged -0.54±1.61△, the near phoria were measured to be -0.46±1.60△ three months after surgery. Before and after surgery, the far and near phoria differences were not statistically significant. The value of stereo-acuity before refractive surgery were measured to be 52.40±12.70sec, a week after surgery were 63.00±14.74sec, the value of one month after surgery 60.00±12.94sec, the values of three month were measured to 52.80±12.13sec(F=8.06, p<0.001).

**Conclusions:** There were reduction in accommodation and stereo-acuity for patients underwent myopic refractive surgery a week after surgery and both functions increased to baseline 3 months after the surgery.

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**Knowledge, attitudes, and practices- major barriers for the ‘effectiveness coverage’ of eye health services in a rural community of Nepal**

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**Purpose:** Lack of awareness and health-seeking behaviour, and harmful practices are thought to be the major causes of poor eye health in rural communities. The aim of this study was to assess the knowledge, attitudes and practices (KAP) of people on eye health, in a rural community in the eastern hills of Nepal, and analyze their impact on the effectiveness coverage of eye-care services.

**Methods:** Key informants of the 317 households (16% of total) of Fikkal, Ilam were identified by systematic stratified proportionate random sampling Methods. They were interviewed using pretested semi-structured questionnaire. Information about KAP on cataract, glaucoma, ocular injury, refractive errors, strabismus, xerophthalmia and other eye diseases were collected and analyzed.

**Results:** 64.0% (n=203) of the respondents had heard about cataract, 43.9% (n=139) had heard about night-blindness and only 6.0% (n=19) had heard about Glaucoma. Only 35.0% (n=111) of the respondents said that they would go to the hospital if they had ocular problems; 18.0% (n=57) would visit traditional healers, and the remaining 47.0% (n=149) would wait for the free outreach programmes organized occasionally by some organizations. Out of 23.0% (n=73) respondents who used spectacles in the past, none were wearing when we visited them. 34.2% (n=25) of them said that it was difficult to work with the spectacles, and 31.5% (n=23) had their spectacles broken. Of the 61.6% (n=45) who wanted new spectacles, 87% (n=39) said that cost was the major barrier.

**Discussion:** Although there is a tertiary eye centre in within a reasonable reach, there is a lack of ‘effectiveness coverage’ of eye care services in this community due to low level of awareness, cost and less service satisfaction. Public health education on prevention and treatment of ocular diseases, and services targeted to the poor people, should be planned and implemented.
The patient in-store experience at optical practices
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Objective: This aims to discuss the business opportunity of walk-in customers to an optical practice and to share valuable insights of the positive impact of creating a great in-store experience for the customers by understanding their needs, lifestyles & eye health requirements. Such effective customer engagement at the optical outlet level is a key criterion for a successful optical practice.

Methods: Extensive research to understand customers' insights in eye care practitioners'(ECP) stores were carried out. Solutions for the contact lens category were then formulated & designed to reflect these insights.

Results: First impression of the store such as the window display will likely determine if the customer will walk into the store. Inside the store, majority of customers will browse the frame display, engage with shop assistants and scan the posters in the store. Engagement with the store assistants are the key leading to purchases. Professionalism displayed during communications and attentive listening gains the customers' trust and makes them feel relaxed. 50% of customers will consider wearing contact lenses. 88% of customers will accept if offered a contact lens trial on site. By doing so customers will spend more on spectacles as they are able to see the range clearly and make the right choice for themselves. Customers will also purchase contact lens in that moment or in future, as a result of trialing them.

Discussion: Efficient outlet standards will drive and deliver growth for store owners' businesses. Proactively recommending contact lenses and offering them to a wider range of customers can make a major difference to the success of store owner's businesses. But at the end of the day, store staffs are the ones playing the crucial role to determine if the purchase is accomplished.

The effect of customer satisfaction and brand loyalty in optical shop service quality factors
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Purpose: To study the impact of service quality factors in optical shops on customer satisfaction and brand loyalty.

Methods: 71 consumers (M:31/F:40) (Franchise:32/General:39) who had experience using the optical shop in Seoul, Gyeonggi province area had conducted a survey by 8 to 31 May 2013. They were collected by self-entry of the respondents; it was measured in the Likert 5-point scale. Using the Cronbach’s Alpha coefficient for reliability testing, we conducted multiple regression analysis and the t-test, statistical processing by SPSS2.1 program. Refer to Jung (2005), Suh, Lee (2006) of the preceding paper, a component of VMD (functionality, information, attraction) and KS-SQI (accessibility, reliability, customer response) that had been modified to fit the optical shops.

Results: The verification results of regression model (R²=.620, F=29.563(p<.05)), it had adopted attraction, reliability, customer response except physical environment as factor impacts on customer satisfaction (p<0.05). In the regression model(R² = .481, F = 17.218, (P <0.05)), It had adopted reliability, customer response, except the physical environment, attraction as factor impacts on brand loyalty (p<0.05). It was surveyed to exert a high impact in this order; reliability, customer response. In franchised optical shops, regression models of service quality factors and customers satisfaction (R²=.660, F=16.066(p<0.05)) adopted customer response, physical environment were in order (p<.05).
Regression models of service quality factors and brand loyalty ($R^2 = .410, F = 6.375(p < .05)$) adopted only customer response.

**Discussion:** As per Park’s research (2007) utilizing VMD factors and Kim’s research (2009) utilizing KS-SQI, in optical shops, it was found to give a significant effect on customer satisfaction and service quality factors utilizing Both VMD factors and KS-SQI. Among them, because they exert a high impact in the order customers’ response, reliability, attraction, it was possible to confirm that, more than physical services, personal service is relatively important.

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**Correlation of stress to visual related symptoms among employees and safety security staff of the Manila Central University**

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**Purpose:** This study is about the correlation of stress to visual related symptoms, since there are some factors of stress that affects vision and some symptoms are accompanied by visual problems.

**Methods:** The descriptive method of research was utilized in this study. It includes interviews, guided questionnaire, observation and visual examination. Purposive sampling Methods has been applied in this study. 40 respondents were included. The stress checklist by Joyce Kenyon, a stress mastery trainer was utilized to determine if the respondents were undergoing stress of mild, moderate or severe in physical, emotional, mental, spiritual symptoms based on the different stressors such as work-related or non-work related.

**Results:** Most of the respondents' level of stress related to physical symptoms was mild stress with 52%, followed by severe stress with 25%. Physical symptoms that are present among respondents included chronic fatigue, headaches, backaches, frequent colds or allergies, ingestion, nausea, diarrhea, constipation, palpitation, muscle cramps, dark wrinkles under eyes, frequent frowning, clammy palms, frequent yawning, sighing, driving or moving faster than needed, and cold sweats.

The most common level of stress as to emotional symptoms among respondents was mild stress with 50%, and the remaining respondents were under non-stress, moderate and severe stress with 18%, 13% and 10% respectively. Those emotional symptoms that were included in the stress checklist were depression, frequent arguing, eating disorder, irritability, angry outbursts, feeling alienated, excessive drinking and drug or substance abuse.

Most of the respondents' level of stress as to mental symptoms was mild stress with 35%, followed by non-stress and severe stress with 23%, and the remaining respondents were having moderate stress with 20%. The most common mental symptoms among respondents were worrying, boredom, anxiety, feeling overwhelmed, insomnia, confusion, impaired activity and difficulty in concentrating. 77% of the respondents were non-stress spiritually and the remaining respondents were having mild stress with 23%.

The level of stress reported by the respondents as caused by pressure at work were mostly mild stress with 49%, severe stress (23%), moderate stress (15%), and non-stress (13%). Those work pressures were time pressures or deadlines, filing deadlines, office politics or tension, client or partner expectation and demands, client load or heavy case, returning phone calls, competition and generating more clients.

Level of stress reported by the respondents as caused by nature and environmental factors such as population density, pollution, noise, threat of earthquakes, fires, flooding and riots, and global conflicts resulted to mild stress of the respondents with 42%. Level of stress reported by respondents at home such as family demands on time and attention, family tensions, financial pressure and satisfying personal wants and needs may lead to mild stress with 49%, moderate stress with 28%, severe stress (20%), and only 3% are non-stress.
Conclusion: Most of the respondents were experiencing visual related problems such as blurring of vision, glare, double vision and floaters. The prevailing refractive status among the respondents was emmetropia with 72.5% and myopia with 17.5%. Thus, blurring of vision or visual related symptoms is not attributed to error of refraction and may be due to stress. There is a significant relationship between stress as caused by work pressure, environmental factors, work changes and problems at home and visual related symptoms. The calculated value of chi square test at 0.05 level of significance is 25.48 as compared to critical value of 16.92 hence, the null hypothesis was rejected.

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The role and influence of the Indian Optometric Association in shaping the profession of Optometry in India

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Purpose: To analyzed the Growing of the optometric profession in India- and what new strategies should be adopted

Methods: The development of the optometry profession by the oldest optometric organization in the country—the Indian Optometric Association. IOA has over 2000 registered members across the country. IOA has been regularly hosting National Conferences. The Indian Optometric Association is a 45 years old Association actively involved with the upliftment and upgradation of the profession of optometry in India. IOA is the internationally recognized body for verification and authentication of job applicants seeking employment as optometrists in foreign countries. IOA has hosted WCO GDM -joint meeting of IOA, WCO, APOC and Vision 2020 members in Goa.

Results: The IOA has been conducting the major activity of Continuing Education program on a regular basis all over the country to promote optometric education in India. IOA played major roles in the formation of ASCO-INDIA-year 2004, IOF-year 2011. IOA has been actively celebrating World Optometry Day and World Sight Day advocating eye care and eye wear amongst the masses and promoting Optometrists as primary eye care physicians. IOA has given a very important presentation and submitted reports about Indian optometry in 2006 to the Sixth Pay Commission which is a government apex body catering to Pay Scale of government employee and educational standard.

Conclusion: The important role of the optometrist in prevention of blindness is accepted; economically it is also a high revenue generator for the government. The IOA has submitted its representation to the Standing Committee of Parliament of India for highlighting Optometry as an independent profession and for regulation of optometry services under the National Health Commission of human resources which is a primary and priority based strategy for the last few years. The increase in the number of optometry institutes in the past 10 years reflects that Optometry is a prestigious and sought after career choice as a respectable profession in India.

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Continuing education program in Optometry and its benefits to various sectors in Mumbai

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Purpose: To evaluate the importance of optometry education at various levels in Mumbai.

Methods: The study was conducted with students enrolled in Optometry, Optometry educators, practicing Optometrist, and Industry in Optometry during the year March 2010- April 2013. Open ended questions were asked about the benefits to the all participants. The data was collected from different
colleges of optometry in Mumbai at diploma and degree level for students, and degree level for other participants. The data was segregated in 4 different groups.

**Results:** Industry benefitted in knowledge, advertisement, interaction, awareness about new product and research in Indian population, quality, service and excellence. Students benefitted in growth in education, individual professional development, satisfaction of attendance, interaction. Educators gained in new teaching methods, awareness in optometry and access to organization. Practitioners benefitted in interaction with optometry colleagues, more ideas, skills, and hands on experiences, employment opportunities, professional development, and public relation activity.

**Discussion:** Continual education is must for all levels of Optometrists irrespective of age and experience. The results reinforced the clear relationship between engagement and key business metrics such as financial performance, retention, and a company’s ability to attract talent. Effective education execution is paramount to success. There are challenges, but knowledge, focus, and an integrated approach will ensure that the business survives and thrives under all economic conditions.

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**The development of Contact Lens Assistants in Hong Kong - A step forward to the development of para-optometric profession in Hong Kong**
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**Purpose:** As a company with a strong commitment in developing the profession, Johnson & Johnson Vision Care partnered with the Hong Kong Polytechnic University (PolyU) and the Contact Lens Research Association to organize a Contact Lens (CL) assistant training course with the objective of developing the para-optometric profession and advancing the optometric profession in Hong Kong. The development and qualification of CL assistants is expected to help optometrists in managing both first time and current CL wearers.

**Methods:** Forty-four front line staffs from optical chains and private optometry clinics were selected to enroll in a 12 hours certification CL assistant training course. The objective of this course is to equip front line staff with basic knowledge of contact lens as well as Insertion and Removal (I&R) skills. The course was taught by lecturers appointed by the Hong Kong PolyU. Written and practical examinations were conducted to assess the knowledge and skills of the participants. Post-training survey was conducted to evaluate in-store behavioral change of those who have successfully completed the course.

**Results:** Out of the 44 enrolled participants, 42 participants passed the CL assistant training course and qualified to be CL Assistants. Post training results revealed: (1) 25% increase in contact lens sales growth in the trained stores vs 15% increase in non-trained stores; (2) 90% CL assistants revealed increase in confidence level and pro-activeness in managing first time and current contact lens wearers; (3) 90% CL assistants reported an improvement in communication with optometrists when managing contact lens wearers.

**Discussion:** Post training results indicated positive impact to the contact lens category and improvement in confidence level and communication skills of qualified CL assistants. Similar course expanded to additional optical stores and optometric practices can be considered.

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**Utilization of concept of vergence in tutorial education in Optometry**
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**Purpose:** In tutorial education of ophthalmic optics, mainly geometrical ray optics is used. If we could pay a little bit more attention on the wavefront, that is perpendicularly crossing the ray bundle, rather than the ray itself, it might be much more helpful for students when they are proceeding to advanced stage in optometrical optics including various wavefront aberration problems. The concept of vergence is a bridge connecting ray optics to wavefront-based optics.

**Methods:** In the paraxial approximation, vergence is usually understood as a measure of the refractive power of a lens or as an optical variable defined as medium refractive index, \( n \), times the reciprocal of distance, \( 1/z \), in unit of meter \(-1\) or diopter \( D \), that is, \( n/z \). Students might have difficulty to understand and recognize this definition. To let them overcome this difficulty, it is helpful to give definite physical image on this definition. Reciprocal distance \( 1/z \) is understood as the curvature \( C \) (inverse of radius of curvature) of spherical wavefronts or spherical refractive boundaries. Then \( n/z \) corresponds to \( nC \). Therefore the vergence can be called as “optical curvature” where “optical” is used in the same sense as in term of the “optical length” \( nz \). Thus vergence is understood as equivalent curvature change accompanying with wavefront travel in air in the same time-lapse in medium of refractive index \( n \).

**Results and Discussion:** Under the above preparation, with the help of the Huygens’ Principle, the optical imaging formula for a spherical refractive boundary expressed in vergence can be led without using any definition of vergence. Procedure for introducing the vergence imaging formula will help students to understand the concept of vergence and let them become familiar with wavefront aberrations encountering in various optometrical scenarios. Examples of aberration calculation based on vergence are given in the poster.

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**Optometry Program in Nepal**

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**Purpose:** To produce competent, compassionate and community oriented optometrists who can deliver primary health care of eye and visual system.

**Methods:** The Degree of Bachelor of Optometry program was commenced by Institute of Medicine (IOM) in 1998 in collaboration with the University of Auckland, New Zealand as a result of National Workshop on “Human Resource Development”. Every year, 6-8 candidates are selected on merit basis of Medical Entrance Examination held by Exam Control Division, IOM. Students are provided with lectures, demonstration, and training on systemic, ocular and vision related topics. They are simultaneously posted in eye clinics of BP Koirala Ophthalmic Center, satellite clinics, community outreach programs, and community field diagnosis. Students must pass the internal evaluation and university examination for four years to get the degree.

**Results:** Sixty two optometrists are graduated from the institute. 95.2% of them are national students. Among 59 optometrists, 27 (45.8%) are engaged in hospital and institution based practice, 18 (30.5%) are employed abroad or in further education, 14 (23.7%) are involved in private practices. This program offers training on various optometry related specialties such as refraction, dispensing, geriatric, and pediatric and community optometry, low vision, contact lens and orthoptics. However, the program doesn't include training on sports and occupational vision, Neuro-imaging, ethics, optometry management and business, and visual rehabilitation.

**Conclusion:** Optometry program is successfully implemented in Nepal. However, current curriculum has to be revised to meet international standard and produce higher qualified optometrist in Nepal.
The effects of continuing education on ECP’s confidence in fitting contact lenses
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Introduction: As the market of contact lenses in Korea has been remarkably growing over the last few years, the responsibilities of eye care professionals (ECPs) have become more important than ever. Consequently, many ECPs have been keen to educate themselves with up to date contact lens information and the importance of continuing education has soared lately. The aim of this study is to investigate the effects of continual education on ECP’s confidence in fitting contact lenses and look into benefits that can be brought to practices.

Methods: A written survey was chosen to collect data from 1053 ECPs (n=1053) who attended courses at The Vision Care Institute in 2012. Pre-survey was conducted before each course commenced and post-survey was conducted after each course to collect the data of pre and post education effects.

Results: The data analysis showed an increase in the confidence of toric contact lens fitting (56.7% to 89.3% annual average (aa) and an increase in the confidence of spherical contact lens fitting (69.0% to 90.3% aa). Simultaneously, ECPs’ minds also showed a change that ECPs’ willingness to satisfy contact lens patients rose from 72.7% to 96.1% (aa). More interestingly, the percentage of ECPs who would try to increase the profitability of contact lenses in their practices increased from 37.4% to 92.4% (aa).

Conclusion: The positive effects of continuing education on ECPs were evidently demonstrated. From the results, we could conclude that continuing education will provide ECPs with contact lens knowledge and strengthen their confidence levels of fitting contact lenses. ECPs are more willing to fit contact lenses and hence increase contact lens business in their practices. Inevitably, ECPs need to be equipped with the latest contact lens knowledge through continuing education, especially with the significantly growing contact lens market in Korea.

Drug delivery-controlled hydrogel contact lens using crosslinkers
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Purpose: This study was to prepare various types of hydrogel contact lens containing different types and quantities of crosslinkers and to compare the ophthalmic drug elution concentration and the drug delivery rate.

Methods: Two types of crosslinkers, ethyleneglycol dimethacrylate (EGDMA) and poly (2-hydroxyethyl methacrylate-co-3,9-divinyl-2,4,8,10-tetraoxaspiro [5.5]-undecane) (U), were used when preparing hydrogel contact lenses. The quantity of the crosslinkers was varied as 0.1%, 0.5%, 1%, and 5% of the quantity of various types of monomers in order to prepare contact lenses of different physical properties. The contact lenses were prepared in a dry method using a cast mold. The rate of drug delivery depending on the type and quantity of the crosslinkers was compared in order to control the drug elution rate. The water content, refractive index, tensile strength, and drug elution rate were compared between the basic hydrogel contact lens made of HEMA and the contact lenses containing NVP, a high water content monomer, or styrene, a low water content monomer.

Results: The water content was decreased in both the high water content and the low water content contact lenses as the crosslinker quantity was increased, but the reflective index was unchanged or slightly increased. This trend was found in both of the EGDMA and U crosslinkers. The drug elution rate
was higher in U than in EGDMA. The HEMA and NVP contact lenses showed a pattern that the drug elution rate was high in the early stage but it remained constant after six hours. The drug elution rate was the lowest in the contact lens containing styrene, a low water content monomer, but it was relatively uniform from the early stage.

**Discussion:** The types and quantities of crosslinkers affected not only physical properties of the contact lenses but also controlling the drug delivery effect and delivery rate.

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**The impact of various simulated visual impairments on a task of eye-hand coordination**

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**Purpose:** People with visual impairment may experience accidents when reaching for objects but the influence of different types of visual impairment is unclear. Therefore the purpose of this study was to compare the impact of simulated visual impairment on a task of visual search and reaching efficiency.

**Methods:** Twenty five students volunteered (mean age=21.76 ±1.90) who have more than 0.0 logMAR visual acuity (VA). Zimmerman Low Vision Simulation Kit was used for simulating optical blur, cataract and visual field defect. The VA of simulated cataract and optical blur was matched (1.0 logMAR) and there were three conditions of visual field defect (3, 7 and 10 degree of visual field). Wayne saccadic fixator with the setting of self-pacing timed for 30 seconds with random pattern was used for measurement of eye and hand coordination and the number of flashing lights correctly depressed was counted.

**Results:** The number of flashing lights correctly depressed was significantly different among the conditions (p<.05). The number of flashing lights depressed for each condition was as follows: 32.52±2.93 for normal condition, 25.80±3.38 for simulated cataract, 28.80±3.47 for optical blur, 3.36 and 5.58±2.34 for average of all visual field defect conditions. Within the visual field defect condition, there was also significant difference by degree of visual defect (p<.05).

**Conclusion:** Visual impairment can have adverse effect on eye and hand coordination. Results suggest that severe peripheral visual field constriction may have a worse effect than general depression of the visual field.

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**Upgrade optometric practice in China: situation and solutions**

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**Purpose:** To investigate current optometric practice (knowledge, attitude and performance, KAP) by using a comprehensive assessment tool developed in Brien Holden Vision Institute (BHVI), and implementing it on optometric practitioners in key cities in China.

**Methods:** The essential optometric skills including refraction, optical dispensing, and contact lens fitting were assessed using the BHVI instrument. Two experienced examiners conducted evaluations on 103 optometric practitioners from four cities in China. A questionnaire was implemented to understand the
practitioners' education background, status of professional development and practice scope and workload, in addition to a professional competency assessment.

**Results:** 71 eye care practitioners (ECPs) and 32 practitioners with training experience (trainers) accepted the assessment. The optometric practitioners with training experience performed higher than normal ECPs across all assessment sections (P<0.05), while the accuracy of the refraction for either trainers or ECPs were not satisfactory, according to levels set by BHVI. Significant differences in knowledge and skill levels exist across regions in China with a low proportion of optometrist with formal optometric training (59% in ECPs and 66% in Trainers).

**Discussion:** The difference in performance between trainers and ECP’s may be due to a difference in the level of experience and level of theoretical training. The poor performance exhibited in basic optometric skills may be due to a lack of formal training and incentive for continuing professional development. This finding raises the demand of further investigation and possible solutions to advance optometric practice in China.

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**A study on the change and recovery of phoria during and after watching 3D TV**

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**Purpose:** Interest in the changes of ocular functions when watching 3D TV or movies is increasing due to the popularization of 3D TV or 3D movie. This study is to investigate the change of phoria during watching 3D TV and recovery of phoria after watching 3D TV.

**Methods:** 50 university students (male 30, female 20) who can perceive stereopsis participated in this study. Phoria was determined at 3m for distance and 40cm for near using Howell phoria card. Phoria was measured before watching 3D TV and every 10 minutes for 30 minutes during watching 3TV, and every 5 minutes for 30 minutes after watching 3D TV.

**Results:** The results showed that distance phoria significantly increased from exo 0.80 ± 1.12 Δ for before watching 3D TV to exo 1.00 ± 1.28 for after watching 3D TV (paired t-test, p < 0.05). Phoria recovered to the level of before watching 3D TV 20 minutes after finishing watching. Near phoria was significantly increased from exo 4.36 ± 3.66 Δ for before watching 3D TV to 6.58 ± 4.63 Δ for after watching 3D TV(paired t-test, p < 0.05), and recovered to the level of before watching 3D TV 25 minutes after finishing watching.

**Discussion:** Watching 3D images induces an increase of exophoria. The amount of increase was higher for near phoria than for distance phoria, and recovery time was also longer for near phoria than for distance phoria. Increase of exophoria in watching 3D TV may occur by mismatching between accommodation and convergence differing from normal binocular vision state.

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**Visual functions in orphans of Nepal**

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**Purpose:** In Nepal, the number of orphans has increased in the past decades, with a marked increase from 1996 to 2006, due to internal conflicts. Orphans are likely to have poor access to health care.
However, there are few statistics on the prevalence of visual impairments in orphans in the low income countries. The purpose of this study was to determine the visual functions in Nepalese orphans.

**Methods:** Detailed ocular examination was done in 568 children residing in an orphanage between 3 to 15 years of age, which included visual acuity assessment in Log MAR, anterior and posterior segment evaluation, objective and subjective refraction and Orthoptic evaluation. Orthoptic evaluation included convergence, accommodation, stereopsis and prism fusion range measurements. Data were analyzed using Stata 12 software.

**Results:** Mean visual acuity in both eyes was 0.12 ±0.079 Log MAR. 27.12% (n=154) of children had refractive error. Among them, 48.05% (n=78) had simple myopia followed by compound myopic astigmatism 22.04% (n=34). Mean positive fusional vergence at near were 30.71 (95% CI: 29.86 to 31.54). Amblyopia was found in 0.52% (n=3) cases. Two children had unilateral optic atrophy. About 22.88% (n=130) of children had Orthoptic problems; 61.53% (n=80) had fusional insufficiency followed by 22.30% (n=29) with vergence and accommodative problems. Convergence insufficiency was found in 13.84% (n=18) of the cases. Intermittent Exotropia was present in two children.

**Conclusion:** The findings in this study suggest that orphans have more visual problems than children reported in the population based surveys conducted in the same region.

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**Prediction of axial length using keratometry and refractive error**

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**Purpose:** Our study aimed to derive and evaluate an equation for predicting axial length, to be used to design individual optimized progressive addition lenses (PALs), based on keratometry and refractive error.

**Methods:** This study comprised 50 subjects (100 eyes) with mean age 49.6±10.2 years. None of the eyes examined had a history of surgery or trauma. Subjects with systemic and eye disease were excluded from this study. We estimated corneal radius, manifest and cycloplegic refraction, and axial length (by IOL-master). With these data and Gullstrand reduced eye, we made a formula which predicts axial length, verified the formula to each subjects.

**Results:** The equation that predicts axial length was found to be AXL=(24.00*CR/7.8)-(SE*0.36), where AXL=predicted axial length, CR=corneal radius, and SE=spherical equivalent. Predicted mean axial length were 24.54±1.67mm and real mean axial length were 24.42±1.60mm. The mean difference between the two axial lengths was 0.31±0.25mm. The predictions of axial length for 81% of the subjects (81/100 eyes) were within ≤0.5mm of measured axial lengths, 17% (17/100 eyes) within 0.5-1.0mm, and 2% (2/100 eyes) within 1.0-1.5mm.

**Discussion:** It is difficult for many eye care practitioner to easily obtain reliable axial length without dedicated instruments. For those who wish to design PALs in clinical fields, axial length can be predicted with accuracy using a formula involving keratometry and refractive error.

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**A case of bilateral simultaneous two stages laser assisted in situ keratomileusis in a presbyope**

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Case History: A 67-year old male visited Eye Institute with a desire to get rid of glasses for both distance and near.

Objective Measurement Taken: Manifest refraction on both eyes was +2.00 Ds with 20/20-1 and 20/20 for far in right and left eye respectively and Add +2.50 Ds with J1 at near in both eyes. Corneal topography showed central corneal thickness of 531µm and 536µm in right and left eye respectively. In Schirmer test both eye had 35mm in five minutes. Axial length was 23.55mm and 23.39 mm in right and left eye respectively, keratometry reading was R1= 7.91 X 78° and R2= 7.89 X 168° and R1= 7.93 X 26° and R2= 7.84 X 116° in right and left eye respectively. Anterior chamber depth was 3.07mm and 3.15mm in right and left eye respectively. Pupil size at photopic condition was 2.06mm and 2.53mm in right and left eye respectively whereas in mesopic it was 4.29mm and 4.58mm.

Assessment: Both anterior and posterior segment was within normal limit. Along with detail examinations of corneal health and manifest refractive error no risk factors was found for simultaneous two stages Lasik.

Case management planned: With written consent of the patient, NIDEK EC-5000 wavefront hyperopic LASIK for distance in 1st stage and Pseudo accommodative cornea (PAC) making distance center and near peripheral optic zone for near after 6 months simultaneously in both eyes was planned. Subsequent follow up was planned after 1day/1week/1month/3month.

Discussion: There are various risk involved while doing the bilateral simultaneous Lasik than unilateral. It’s a daring procedure. Although the age of the patient was 67 yrs which is higher than the high limit of other studies, uncorrected visual acuity on next day of 1st stage Lasik was very good 20/20 at distance and J7-2 at near binocularly. On subsequent follow-up on 1week/1month/3months there were no significant problems with patient and cornea was healthy, so second stage was performed. And the results were awesome. On his last follow up, the uncorrected binocular vision at distance was 20/22-2 and J3-2 at near. This is far better than uncorrected binocular visual acuity of patient before LASIK; 20/140-1 at far and 20/400 at near. Depending upon the case there are advantage and disadvantages of doing bilateral simultaneous two stages LASIK in presbyope. It is a very good refractive surgery for those who don’t want to wear glasses or contact lenses for distance and near. It is safe, efficacious and predictable.

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The impacts of LED and fluorescent light sources on visual perception
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Purpose: This study aims to find the impacts of LED and fluorescent light sources on visual perception among young adults of around 20 years of age, who had lots of visual activities at close range.

Methods: 30 people who had no binocular dysfunctions and dyschromatopsia with best-corrected visual acuity are recruited. Subjects were examined with CISS - a symptom evaluation tool at close range, preliminary, refraction and binocular function tests. Lighting environment was illuminance 700 ± 30 lux; color temperature of the LED was each 3,000K, 5,000K, 7,000K and fluorescent light was 5,000K. Therefore four conditions were set and then the visual perception was examined. Evaluation of visual perception was conducted in error correction and the reading operation.

Results: The results of this study, accuracy of error correction according to the color temperature of LED and fluorescent light sources appeared highly in order of LED 5,000K > LED 7,000K > LED 3,000K > fluorescent light source 5,000K. The required time in reading operations was the shortest in LED 7,000K and the longest in the fluorescent light source 5,000K. A total of 10 reading operation test
had the highest accuracy in fluorescent light sources LED 5,000K and the lowest in fluorescent light sources 5,000K. The error correction accuracy in color temperature of LED and fluorescent light source 5,000K was higher at fluorescent light sources than LED. The required time of reading operations was less in LED 5,000K than fluorescent light source 5,000K. Reading operation test also had higher accuracy at LED 5,000K than fluorescent light source 5,000K.

**Conclusions:** The type of light sources and color temperature had an effect on the visual perception. Also the findings from this study can be used to choice the appropriate lighting environments for visual perception improvement and visual operation environment in the future.