**Title**
ACCOMMODATION AND CONVERGENCE DURING SUSTAINED COMPUTER WORK

**Program Number**
060034

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**Topic**
Binocular Vision

**Day**
Friday, December 08, 2006

**Time**
9:15 AM-9:30 AM

**Room**
Room 706

**Abstract**
**PURPOSE:** With computer usage becoming almost universal in the contemporary workplace, the reported prevalence of computer vision syndrome (CVS) is increasing. However, the precise physiological mechanism underlying CVS remains unclear. While abnormal accommodation and vergence responses have been cited as being responsible for this condition, there is little objective evidence to support this claim. Accordingly, this study measured both of these oculomotor parameters during a sustained period of computer use. **METHODS:** Subjects (N=20) were required to read text from a laptop computer at a viewing distance of 50cm for a sustained 30 min period through their habitual refractive correction. At 2min intervals, the accommodative response to the computer screen was measured objectively using a Grand Seiko WAM 5500 optometer. Additionally, immediately following the accommodation measurement, the vergence response was assessed by measuring the associated phoria (AP), i.e., prism to eliminate the horizontal fixation disparity using a customized fixation disparity target which appeared directly on the computer screen. Subjects were asked to rate the degree of discomfort during the reading task on a scale from 1-10. **RESULTS:** Mean accommodation and AP values were 1.07D and 0.74PD exo, respectively. The mean discomfort score was 4.9. No significant change in accommodation or vergence was observed during the 30min test period. There was no significant difference in the accommodative response as a function of subjective difficulty. However, the mean AP for those subjects who reported the least and greatest discomfort during the task was 1.55PD exo and ortho, respectively (p=0.02). **CONCLUSIONS:** CVS was worse in subjects exhibiting zero fixation disparity, but does not appear to be related to differences in accommodation. A slightly reduced vergence response increases subject comfort during the task.

**Key Words**
Accommodation, Environmental vision, Vergence anomalies
**Title**
COMPARISON OF OBJECTIVE AND SUBJECTIVE MEASURES OF ACCOMMODATION IN STANDARD PSEUDOPHAKIC SUBJECTS

**Program Number**
065394

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**Topic**
Optics and Refraction

**Day**
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**Time**
-

**Abstract**

**PURPOSE:** With the advent of new surgical procedures and intraocular lenses (IOL) to restore active accommodation to the eye, objective accommodation measurement is as essential as subjective testing. Previous objective testing with a clinical autorefractor and aberrometer demonstrated dioptric changes with accommodation in phakic young adults and pre-presbyopes. This study compared objective measures of accommodation with the Grand Seiko WR-5100K (GS) autorefractor and iTrace (IT) aberrometer to subjective ‘push down’ and defocus tests in pseudophakes with standard IOLs attempting to “accommodate” at near.

**METHODS:** 10 subjects, aged 43-76 years old (mean 66.2±11.23) participated. Two methods were used to stimulate and measure accommodation subjectively: 1) the ‘push-down’ test using an RAF rule and 2) defocus curves measuring distance corrected visual acuity (DCVA) through trial lenses of decreasing power from +3.00 to -4.50D in 0.50D steps. For objective testing, a near target was “pushed up” to 3.50D and the refractive response measured with the GS and IT. Calibration tests to verify instrument accuracy were done on pseudophakic eyes with soft contact lenses using the GS and IT.

**RESULTS:**
The accommodative amplitude with subjective push-down test was 3.28±1.11D (mean ± SE) OD, and 3.64±1.38D OS. Defocus curves shows a range of 2.00D for DCVA of 20/40 or better. Objective testing measured 0.36 ±0.59D with the GS and 0.24±0.49D with the IT. Calibration testing showed good agreement with the 1:1 line, with slopes of -0.96 for the GS and -1.10 for the IT. **CONCLUSIONS:** While pseudophakes with standard IOLs are not expected to accommodate, the subjective tests overestimated the objective measures and measure depth of focus rather than true accommodation. The GS and IT results were similar for the pushed-up test and contact lens calibration. The calibration test shows that both instruments are reliable for objective accommodation measurement testing in pseudophakes.

**Key Words**
Accommodation, Instrumentation, Clinical assessment/procedures
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<th>DOES THE DYNAMIC CROSS CYLINDER TEST MEASURE THE ACCOMMODATIVE RESPONSE ACCURATELY?</th>
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**Abstract**

**PURPOSE:** The dynamic cross cylinder (DCC) test is a standard clinical procedure used to assess the accommodative response (AR) subjectively. Astigmatism is induced, and the patient’s subjective response to a rectilinear target indicates whether a lead or lag of accommodation exists. Spherical lenses are introduced during this subjective technique to quantify the accommodative error. However, due to potential problems arising from the compound dioptric stimuli, it is unclear whether this test provides an accurate measure of the AR. Accordingly, the aim of this study was to compare clinical subjective findings with objective measurements of the AR. **METHODS:** Subjective findings to a 2.50D accommodative stimulus were compared with objective measurements of the AR obtained using a Grand Seiko WAM 5500 optometer in 25 young subjects. When spherical lenses were introduced to quantify the subjective finding, objective measurements of the AR were also recorded through these lenses. **RESULTS:** The mean AR recorded subjectively and objectively was 2.35 and 1.68D, respectively (p<0.0001). Of the 10 subjects who demonstrated a lead of accommodation subjectively, only 1 had a lead objectively. As minus lenses (up to -0.75D) were introduced to achieve subjective equality between the horizontal and vertical targets, the mean AR increased from 1.91D to 3.26D. For the 8 subjects who showed a lag of accommodation subjectively, all had a lag objectively. Plus lenses (up to +0.75D) produced a decrease in the mean AR from 1.29D to 0.64D. **CONCLUSIONS:** The subjective DCC test does not provide an accurate measurement of the AR to a near target. Significant differences exist between the objective and subjective findings. 9 out of the 25 subjects tested appeared to have a lead of accommodation which was not confirmed objectively. In addition, introducing lenses during the procedure alters the AR to the near target. Therefore, this test does not quantify the AR accurately in a young population.

**Key Words** Accommodation, Refraction
### Abstract

**PURPOSE:** The purpose of this study was to evaluate whether variation in axial length or pupil size affected the validity of PowerRefractor readings. **METHODS:** Refractive error was measured on twenty-five adult subjects using three different methods thirty minutes following the administration of 1% tropicamide (range = -8.3 to +2.4 D autorefraction spherical equivalent) The refraction techniques used were: 1) Grand Seiko WR-5100K; 2) Multichannel Systems PowerRefractor; and 3) PlusOptix PowerRefractor. Each PowerRefractor was tested using sphero-cylindrical and vertical meridian only measurement modes. The order of testing was randomized and all tests were performed in one visit by one unmasked observer. Axial length was the average of 5 measurements using the IOL Master. Pupil size was the value reported by the corresponding PowerRefractor mode. Calibration slopes were obtained using spherical trial lenses from -8D to +8D. **RESULTS:** The range of axial lengths was from 21.52 to 26.86mm. The pupil size ranged from 5.8 to 8.6mm. The error of the PowerRefractor was defined as the difference between the PowerRefractor and the gold standard of autorefraction. There was no correlation between axial length and this difference for any of the four PowerRefractor measurement modes (Spearman r range = -0.256 to 0.245; p-value range = 0.24 to 0.93). There was no correlation between pupil size and this difference for any of the four PowerRefractor measurement modes (Spearman r range = -0.360 to -0.05; p-value range = 0.07 to 0.84). There was also no correlation between calibration slopes and axial length or pupil size for any of the four PowerRefractor measurement modes (Spearman r range = -0.360 to -0.05; p-value range = 0.07 to 0.84). **CONCLUSIONS:** The lack of correlation between PowerRefractor error and axial length or pupil size suggests that individual calibrations are not necessary. The lack of correlation between the calibration slopes and axial length or pupil size also supports this finding. **ADDITIONAL COMMENTS:** Supported by NIH NEI grant T35-EY07151.

### Key Words

Refraction, Pediatric
PURPOSE: To investigate changes in higher order corneal aberrations, central corneal thickness, and intraocular pressure after 1 hour of reading. METHODS: 20 myopes (mean Rx = -2.99 ± 1.70 D) and 18 emmetropes (mean Rx = +0.17 ± 0.42 D) between the ages of 22 and 35 yrs (myopes: 24.15 ± 1.35 yrs, emmetropes: 25.67 ± 3.41 yrs) participated in the study. Measurements of refractive error (Grand Seiko WR-5100K Autorefractor), corneal aberrations (Humphrey Corneal Topographer), central corneal thickness (CCT, Oculus Pentacam), and intraocular pressure (IOP, Reichert Non-Contact Tonometer) were taken of the right eye before and after 1 hour of reading. Differences in higher order (HO) aberrations, CCT, and IOP were calculated between baseline and after reading, and then compared between refractive groups.

RESULTS: RMS of HO aberrations significantly increased (p = 0.040) by 0.04 ± 0.08 μm (mean ± SD) after 1 hour of reading, with the difference between myopes (0.06 ± 0.08 μm) and emmetropes (0.01 ± 0.07 μm) approaching significance (p = 0.053). After 1 hour of reading, primary vertical coma became significantly more negative by 0.06 ± 0.07 μm (p<0.001). Significant differences (p = 0.019) were found between myopes (-0.08 ± 0.09 μm) and emmetropes (-0.03 ± 0.04 μm) in primary vertical coma. CCT after reading decreased by 3.6 μm (p = 0.005), with 28/38 (74%) subjects showing a decrease. There were no significant differences between myopes and emmetropes. IOP after reading decreased by 1.1 mmHg (p = 0.002), with 30/38 (79%) subjects showing a decrease. There were no significant differences between myopes and emmetropes. The correlation of HO aberration changes with baseline CCT was low (r = 0.065) and did not differ by refractive group. Similarly, the correlation of HO aberration changes with baseline IOP was low (r = -0.096) and did not differ by refractive group. CONCLUSIONS: Near work induces more HO aberrations in myopes than emmetropes. These changes do not appear to be related to either IOP or CCT.

Key Words: Aberrations/Image quality, Refraction, Corneal topography
PURPOSE: To evaluate the associations between central corneal thickness, anterior chamber depth, anterior chamber volume, axial length, intraocular pressure, and refractive error. METHODS: The study included measurements from the right eyes of 34 adults (mean age = 26.52 ± 5.97 years, mean Rx = -1.59 ± 2.17D). Refractive error measurements (Grand Seiko WR-S100K Autorefractor) were used to determine spherical equivalent (SE). Central corneal thickness (CCT), anterior chamber depth (ACD), and anterior chamber volume (ACV) were measured using a rotating Scheimpflug camera (Oculus Pentacam). Axial length (AL, Zeiss IOL Master) and Intraocular pressure (IOP, Reichert Non-Contact Tonometer) readings were also taken. Soft contact lens wearers were asked to remove lenses 24 hours prior to participation. Statistical analyses included linear regression and Pearson correlation. RESULTS: Mean CCT was 547.71 ± 29.02 μm, mean ACD was 3.24 ± 0.25mm, and mean ACV was 197.76 ± 29.92mm³. CCT showed significant thinning with increasing ACD (r = 0.414, p = 0.015), and with increasing ACV (r = 0.431, p = 0.011). As expected, AL was highly correlated with SE (r = 0.850, p < 0.0001). ACD increased significantly with longer AL (r = 0.529, p = 0.0013) and with more myopia (r = 0.381, p = 0.026). Since ACV and ACD are highly correlated (r = 0.901, p < 0.0001), ACV showed similar significant correlations with AL and SE. There was no significant relationship between CCT and either AL or SE. IOP was significantly correlated with CCT (r = 0.410, p = 0.016), but not with AL, SE, ACD, or ACV. CONCLUSIONS: The new finding of a significant correlation between CCT and ACD suggests that the enlargement of the anterior chamber during periods of eye growth may have stretched the cornea, thereby thinning it. ADDITIONAL COMMENTS: This work was supported by NEI/NIH T35 EY007149 and NEI/NIH R01 EY01191. Affiliations: New England College of Optometry, State University of New York State College of Optometry.
PURPOSE: To validate relative peripheral refraction (RPR) measurements made with the Complete Ophthalmic Analysis System (COAS; Wavefront Sciences) and to examine horizontal visual field RPR differences. METHODS: Thirty subjects underwent cycloplegia with two drops of 1% tropicamide in the right eye. Thirty minutes after instilling the first drop, 10 measurements each were made centrally (along the line of sight), 30º nasal on the retina from the line of sight, and 30º temporal on the retina from the line of sight using both the COAS and the Grand Seiko WR 5100K autorefractor. The first instrument used was randomly assigned. A 2-mm COAS analysis diameter was used to approximate the Grand Seiko measurement beam diameter. Nasal and temporal RPR were calculated as the difference between the average nasal or temporal spherical equivalent (SE) and the average central SE. A repeated measures ANOVA was used to determine if a significant difference existed between the RPR readings of each instrument in each retinal location (nasal or temporal). A repeated measures ANOVA was used to examine SE refractive error in each direction of gaze for both instruments. RESULTS: Subjects ranged in age from 23 to 45 years (mean ± SD = 31 ± 6.7 years). Central SE refractive error as measured by the Grand Seiko ranged from +0.63 D to –8.41 D (mean ± SD = –2.63 D ± 2.05 D). There were no significant differences between the instruments for RPR measurements (p=0.34). Nasal RPR was significantly more hyperopic than temporal RPR (mean ± SD = 0.45 D ± 1.04 D, p=0.02). SE refractive error in all directions of gaze were more myopic with the COAS (mean ± SD = –0.41 D ± 0.61 D, p<0.0001). CONCLUSIONS: RPR measurements with the COAS are feasible and equivalent to those made with the Grand Seiko. The COAS can be used to simultaneously collect RPR and peripheral aberration data. Nasal and temporal RPR measurements were significantly different in our sample. ADDITIONAL COMMENTS: Supported by a Section on Cornea and Contact Lenses Ezell Fellowship (DAB) and by NIH grants (EY015447 & EY013359).
### PURPOSE:
Objective tests for accommodation are clinically important and are typically performed with autorefractors. However, aberrometers may be useful as well. This study evaluated the capability of the Z-View aberrometer (ZV) to measure aberrations and accommodation in young subjects in comparison with baseline aberrations measured with the iTrace aberrometer (IT) and accommodation measured with the Grand Seiko WR-5100K autorefractor (GS).

### METHODS:
15 subjects, ages 21-32 years old (mean 23.7 ±2.8), participated. Subjects were either emmetropic or distance-corrected with contact lenses. For all testing, subjects viewed a distant, back-illuminated letter chart with one eye. The viewing eye was measured and the fellow eye occluded. Baseline wavefronts were measured with the IT and the ZV. Accommodation was measured in response to 0-5D increasing stimulus amplitudes with the GS using negative trial lenses and with the ZV using optical defocusing. The ZV prototype accommodation software was run in automated mode on seven subjects and in automated and manual modes on eight subjects.

### RESULTS:
For distance viewing, Bland-Altman analysis showed agreement in the wavefront data for the IT and ZV. There was no systematic difference in RMS error for low order aberrations. In response to a 5.00D accommodative stimulus, the GS measured 4.23±0.64D and the ZV measured 3.85±0.33D in manual mode and in another group of subjects, the GS measured 4.01±0.41D and the ZV measured 4.09±0.57D in automated mode. Although slight differences were noted between the two instruments and the two ZV modes, these were not statistically significant. **CONCLUSIONS:** The ZV and IT show good agreement in measuring wavefront aberrations. Likewise, the ZV and GS were comparable in measuring accommodation objectively. Furthermore, when the ZV software was run in manual mode, fewer bad readings occurred for the accommodation test than in automated mode. The ZV is a suitable instrument for measuring aberrations and objective accommodation.

### KEY WORDS
Accommodation, Aberrations/Image quality, Instrumentation