Published in final edited form as:
Am J Ophthalmol. 2014 November ; 158(5): 932–938. doi:10.1016/j.ajo.2014.07.041.

Photoscreeners in the Pediatric Eye Office: Compared Testability and Refractions on High-Risk Children

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Abstract

PURPOSE—To compare refractive data and testability of Spot (PediaVision) and Plusoptix A09 (Plusoptix, Inc) photoscreeners and to compare each device with traditional cycloplegic retinoscopy.

DESIGN—Prospective, interventional case series.

METHODS—After informed consent, patients underwent testing with the Spot and Plusoptix photoscreeners before their examination by a pediatric ophthalmologist masked to the results. Data including testability and estimated refractions were entered into a Research Electronic Data Capture database for statistical analysis.

RESULTS—A total of 265 children were enrolled (mean age, 6.0 ± 3.4 years). Both devices produced a computer printout result in 250 (94.3%) of the patients. The Spot photoscreener provided a refractive estimate in all computer printouts, whereas the Plusoptix, used binocularly, provided a refractive estimate in 75.2% (188/250) of the printouts. Compared with cycloplegic retinoscopy, both devices underestimated hyperopia or overestimated myopia (−1.35 diopters [D] and −0.64 D, Spot and Plusoptix, respectively) and overestimated astigmatism (0.36 D and 0.32 D, Spot and Plusoptix, respectively). The intraclass correlation coefficient for spherical equivalents

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ALL AUTHORS HAVE COMPLETED AND SUBMITTED THE ICMJE FORM FOR DISCLOSURE OF POTENTIAL CONFLICTS OF INTEREST and the following were reported. Dr Trivedi receives royalties from Springer. Dr Wilson receives royalties from Springer and he receives free investigational Artisan intraocular lenses from Ophtec. Supported in part by Grant UL1RR029882 from the National Center for Research Resources, National Institutes of Health, Bethesda, Maryland (B.J.W.); a Medical University of South Carolina Clinical Translational Science Award (B.J.W.); Grant UL1TR000062 from the National Center for Advancing Translational Sciences, Bethesda, Maryland, National Institutes of Health, and the Office of Biomedical Informatics Services, South Carolina Clinical & Translational Research Institute (B.J.W.); and an unrestricted grant to the Storm Eye Institute, Medical University of South Carolina, Charleston, South Carolina, from Research to Prevent Blindness, Inc, New York, New York. Involved in Design and conduct of study (M.M.W.P., R.H.T.); Conduct of study (M.M.W.P., R.H.T.); Data collection (C.E.P., J.D.D.); Data management (M.M.W.P., M.E.W., E.W.C., R.H.T.); Data analysis (B.J.W., R.H.T.); Data interpretation (B.J.W., R.H.T.); Manuscript preparation (M.M.W.P.); Manuscript review (M.M.W.P., R.H.T.); and Manuscript approval (M.M.W.P., C.E.P., M.E.W., E.W.C., B.J.W., J.D.D., R.H.T.). The authors thank Luanna Bartholomew for critical review of the manuscript.

indicated good agreement between cycloplegic retinoscopy and Spot (0.806) and excellent agreement between cycloplegic retinoscopy and Plusoptix (0.898).

CONCLUSIONS—The Spot photoscreener provided refractive data on a greater percentage of children. The photorefractors correlated with cycloplegic retinoscopy refractive findings for sphere and spherical equivalents, but underestimated hyperopia or overestimated myopia and overestimated astigmatism. The binocular refractions of Plusoptix agreed more closely with the refractions of our pediatric ophthalmologists.

Photorefractor vision screeners provide a refractive estimate and allow risk factors for amblyopia to be detected even before amblyopia develops. The Spot vision screener was introduced in October 2011 and is marketed by PediaVision (Lake Mary, Florida, USA); PediaVision recently was purchased by Welch Allyn (Skaneateles Falls, New York, USA). Currently, there is little published validation of the Spot vision screener.[1,2] The effectiveness of the Spot as a vision screener relies heavily on the accuracy of its refractive results. The Plusoptix S09 and A09 photorefractors are third-generation models of the original Plusoptix 2001 design.[3] The Plusoptix A09 photorefractor (Plusoptix, Inc, Atlanta, Georgia, USA) is marketed to ophthalmology and optometry practices as an autorefractor, whereas the S09 is marketed as a pediatric vision screener. The A09 series provides detailed refraction and pupil and ocular alignment measures for use in eye care professional offices. Traditionally, cycloplegic retinoscopy has been used as the gold standard for determining the refractive status in children.

We aimed to compare the function and refractive data obtained by Spot with those of the more validated Plusoptix A09 and to compare both devices with a pediatric ophthalmology examination that includes cycloplegic retinoscopy. Specifically, our study provided correlation of refractive indices (sphere, cylinder, spherical equivalent [SE], and axis) of these devices with each other and with refractive indices obtained by cycloplegic retinoscopy. The data are reviewed further, comparing results for patients with and without ocular and systemic pathologic features.

METHODS

Prospective approval was received from the medical University of South Carolina Institutional Review Board for Human Research for this prospective interventional case series and written informed consent form. The protocol followed all the requirements for Health Insurance Portability and Accountability Act compliance and adhered to the Declaration of Helsinki. Written informed consent was obtained from a parent or guardian. Patients 1 to 16 years of age seeking treatment for complete pediatric ophthalmologic examination at the authors' institution between June 30, 2012, and January 1, 2013, with appropriate personnel and guardianship available were invited to participate. The study population included new patients as well as patients examined routinely.

THE DEVICES

The Spot is a single handheld device that contains the computer interface and the camera. It is wireless and easily portable. It is held approximately three feet from the subject while the

child looks at the display of twinkling lights and warble sounds. Infrared lights illuminate the eyes, producing reflections from the cornea and the retina while allowing pupil edge definition and a picture. The Spot reports a refraction range of −7.50 diopters (D) to +7.50 D. A report of pupillary diameter, ocular alignment, binocular refraction estimate, and referral recommendation is displayed, stored, and available for printing. The Spot version 1.0.3 and software version 1.1.51 were used. The Plusoptix A09 (software version 5.0.11.0) is an infrared video camera that measures the refractive status binocularly or monocularly and uses eccentric photorefraction. The handheld camera portion provides a moving light and smiling-face fixation target with warble sounds and is attached to a computer screen that displays the child's picture and the findings. The camera analyzes the reflected infrared light from the retina. The A09 model provides a pupillary diameter, ocular alignment, and refraction estimate. It has a spherical and cylindrical range of −7.00 D to +5.00 D. If the camera is able to obtain pupillary distance and ocular alignment from the picture of the child, but not a measurement of refraction, the refraction is listed as "n/a" on the computer printout. Should the measurement fall outside the range of the device for both photoscreeners, the refractive estimate is given as hyperopia or myopia with only a cylindrical estimate provided. Both devices automatically calculate an estimate of SE from the sphere and cylinder measurement obtained.

TESTING

Children were placed in a quiet room before the examination. Testing was conducted by trained lay personnel following the manufacturer's guidelines. The order of testing with the Spot and Plusoptix devices was varied so each was used first an equal number of times during each day. Printouts of the results were collected. The binocular setting on the Plusoptix was used when that device was used. If the device was unable to obtain a picture to provide a computer printout result after several attempts, the tester made the notation "unable to obtain reading."

EXAMINATION BY PEDIATRIC OPHTHALMOLOGIST

A comprehensive examination then was performed including visual acuity, stereopsis and motility evaluation, and examination of the anterior segment. Cycloplegic retinoscopy and fundus examination were performed by the examining pediatric ophthalmologist 30 to 40 minutes after the instillation of proparacaine hydrochloride ophthalmic solution USP 0.5% (Akorne, Inc, Lake Forest, Illinois, USA), followed by 1 or 2 drops of a pediatric combination drop of 1% tropicamide, 2.5% phenylephrine, and 1% cyclopentolate. If the child was cooperative, a subjective refinement was performed. Four experienced pediatric ophthalmologists participated. The physician was not aware of the photorefractor results.

DATA COLLECTION

Collected patient data included age; reading obtained (yes or no); refraction obtained (yes or no); refraction values of sphere, cylinder, and axis for devices and physicians; and diagnoses of systemic and ocular pathologic features. Developmental delay was defined as patients with diagnoses of learning disability, attention deficit hyperactive disorder, autism, developmental delay, or Down syndrome. Ocular pathologic features included diagnoses of glaucoma, corneal opacity, cataract, aphakia, pseudophakia, coloboma, ptosis, having

undergone laser treatment for retinopathy of prematurity, or nystagmus. Data were entered into a Research Electronic Data Capture[4] database hosted at the Medical University of South Carolina for statistical analyses.

STATISTICAL METHODS

We included all patients enrolled in the study, even those from whom one or both screeners were unable to obtain a reading. If a device did not obtain a refractive result, this device was excluded from comparison of the refractive results for this patient. Descriptive statistics were calculated. Differences between each device and the physician's measurement for each of the 4 refractive measures (sphere, cylinder, SE, and axis) were calculated by taking the difference in each rater pair. Because of the correlation for refractive measures on the same patient, we used linear mixed models that included random effects for the patient and for eye (left or right) to account for the correlation between measures taken within the same patient and a fixed effect for the specific rater to examine differences between the methods in the mean differences for each measurement. We used contrast statements to obtain estimates from the linear mixed model of the mean differences for each measure between the Spot and cycloplegic retinoscopy, the Plusoptix and cycloplegic retinoscopy, and the Spot and Plusoptix devices. The variance–covariance estimates obtained from the linear mixed models also were used to examine the within-method variability and the overall variability of readings using the highly flexible intraclass correlation (ICC) to estimate interrater reliability of quantitative data. Note, intraclass correlation values can range between 0 and 1, with a value of 1 indicating perfect agreement and a measure of 0 indicating no agreement. A measure of more than 0.8 indicates good agreement. Because axis measurements are nonlinear, photorefractor axis estimates were compared with the cycloplegic retinoscopy axis values using right eye measures for each screener for those patients from whom a refraction estimate was available. Absolute mean difference and percentage within 20-degree agreement were determined.

RESULTS

The study population included 265 patients 1 to 16 years of age (mean age, 6.0 ± 3.4 years). Most participants (n = 138; 52.1%) were male and a slight majority were white (n = 133; 50.2%; Table 1)

COMPARISON OF DEVICE FUNCTION

A picture result including measurement of pupil size and ocular alignment (allowing a computer printout for the patient) was obtained in most of the patients with both screeners (reading obtained in 250 of the 265 patients, or 94.3%). The Spot provided an estimate of refraction for all patients for whom a picture printout was obtained (100%), with 7 (2.8%) of 250 reported as out of range (< −7.50 D or > +7.50 D). The Plusoptix obtained a refraction estimate for 188 (75.2%) of 250 of these patients. Of these, the refraction estimate was out of range (< −7.00 D or > +5.00 D) in 19 (10.1%) of 188 patients. The Plusoptix provided a computer printout without a refraction estimate (refraction listed as n/a) for 62 (24.8%) of 250 patients. Neither device could obtain a reading from 13 children. Of these children, 7

had significant ocular pathologic features, 6 had developmental delay, and 2 were developmentally normal.

Of the 35 patients with a diagnosis of learning disability, attention deficit hyperactivity disorder, autism, developmental delay, or Down syndrome, Spot obtained a reading for 33 (94.3%) of 35 patients and the Plusoptix obtained a reading for 35 (100%) of 35 patients. Although the Spot provided a refraction estimate for all patients from whom a reading was obtained, the Plusoptix provided a refraction estimate for 82.9% (29/35; Table 2).

Of the 33 patients with diagnoses of other ocular pathologic features (n = 33; including nystagmus [n = 8], cataract [n = 3], aphakia [n = 1], pseudophakia [n = 2], coloboma [n = 2], history of laser treatment for retinopathy of prematurity [n = 3], ptosis [n = 6], and glaucoma [n = 8]), the Spot provided a computer printout reading for 28 patients (84.8%) and the Plusoptix for 26 patients (78.8%; Table 3). Of patients with a diagnosis of intermittent or constant strabismus (n = 96), 92 (95.8%) were able to be tested with the Spot and 87 (90.6%) with the Plusoptix (Table 4). Although the Spot provided a refraction for all these patients, the Plusoptix provided a refraction for 59.8% (52 of these 87 patients). Of those patients without strabismus (n = 169), the Spot obtained a reading for 158 (93.5%) and the Plusoptix obtained a reading for 163 (96.4%) with a refraction estimate in 136 (83.4%) of the 163 children.

COMPARISON OF REFRACTION ESTIMATES

Measurements of sphere, cylinder, and SE obtained by cycloplegic retinoscopy differed significantly from both the Spot and the Plusoptix measurements (Table 5). Both the Spot and the Plusoptix reported smaller values of sphere on average relative to the cycloplegic retinoscopy ($P < .001$ for both). The mean difference in sphere measurements was −1.35 D for the Spot as compared with the cycloplegic retinoscopy measurements. Similarly, the average difference in sphere measurement between the Plusoptix and cycloplegic retinoscopy was −0.64 D. Both devices reported smaller values of SE on average relative to the cycloplegic retinoscopy values ($P < .001$ for both). Related, the mean difference in measures of the Spot SE was −1.16 D relative to the cycloplegic retinoscopy measures and that of the Plusoptix was −0.47 D. However, the Spot and the Plusoptix reported significantly larger (more plus) cylinder values on average relative to the cycloplegic retinoscopy values ($P < .001$ for both), more by +0.36 D with the Spot and +0.32 D with the Plusoptix.

Comparing the 2 devices, the Spot reported smaller spherical values and smaller SE values on average relative to the Plusoptix ($P < .001$ for both). When the mean differences of the 2 screeners are compared, the Plusoptix reported +0.71 D more average sphere than the Spot. However, there were no significant differences between the Spot and the Plusoptix for measures of cylinder or axis. Mean differences between the Spot, the Plusoptix, and the cycloplegic retinoscopy findings are reported in Table 5.

The intraclass correlation coefficients (ICCs) for all 4 measures by each pair of methods are reported in Table 6. The ICCs comparing agreement between the Spot and the Plusoptix, between the Spot and cycloplegic retinoscopy, and between the Plusoptix and cycloplegic

retinoscopy for measures of sphere and SE were all more than 0.8, which indicates very good agreement between the measures. There was also good agreement between the Plusoptix and cycloplegic retinoscopy for the cylinder measure (ICC, 0.805), which is slightly better agreement than with Spot cylinder measure (ICC, 0.716). For patients with significant astigmatism (cycloplegic astigmatism of 1 D or more), there was moderate to good agreement for measurement of the axis. The mean absolute difference in the axis between the cycloplegic refraction and the Spot device (86 patients) was 14.3 degrees (standard deviation, 20.0 degrees), with 83% at 20 degrees or less, and for the Plusoptix device (45 patients), the mean absolute difference was 8.4 degrees (standard deviation, 8.4 degrees), with 91% at 20 degrees or less.

Refractive comparisons are provided for patients with and without strabismus (Tables 7 and 8). The mean differences between the devices and cycloplegic retinoscopy for sphere are more myopic in patients with strabismus (−1.91 D for Spot and −1.11 D for Plusoptix) than in patients without strabismus (−1.04 D for Spot and −0.41 D for Plusoptix). Although the overall ICCs remain high for both devices when compared with cycloplegic retinoscopy, indicating good agreement, there was a drop in the ICC for the cylinder in patients with strabismus (ICC of 0.600 for Spot and 0.779 for Plusoptix) as compared with all patients and with those without strabismus.

DISCUSSION

Our data augment validation studies of the Plusoptix[5–15] and provide function and refractive data comparisons for the newer Spot. We found that both devices performed well, attaining a reading from 94% of children. They are child friendly and are used easily by a layperson. The Spot reported a refraction with all result printouts, whereas the Plusoptix provided a refractive estimate from 75% of result printouts in our high-risk patients. The Spot also provided more refractive data in patients with ocular pathologic features and developmental delay.

Recently updated preschool guidelines for automated vision screeners rely on reliable refractive data.[16,17] Refractive referral criteria continue to undergo refinement.[18–20] We found both devices to underestimate hyperopia (or overestimate myopia). Both the Spot and the Plusoptix reported significantly smaller values of sphere on average relative to cycloplegic retinoscopy—the Spot twice as much (−1.35 D) as the Plusoptix (−0.64 D). Our refractive difference with the Plusoptix is both less than[6] and more than previously reported values.[7] Although these photorefractors are designed to be used without cycloplegia, accommodation still may be variable and may have played a role in the underestimation of hyperopia. The target lights and sounds of the 2 devices are different and may have differing effects on the child and thus on accommodation. Both the Spot and the Plusoptix reported significantly larger cylinder values on average, relative to cycloplegic retinoscopy, by at least 0.3 D. The mean differences in refractive values compared with cycloplegic retinoscopy were consistently less with the Plusoptix than with the Spot. In our patients, overall there was good correlation (ICC > 0.8) between the findings of the physician’s cycloplegic refraction and the refractions generated by the Spot and Plusoptix

photoscreeners. The Plusoptix demonstrated slightly higher ICCs with cycloplegic retinoscopy on all refractive measures in all patients.

Because the devices analyze reflected infrared light from both eyes simultaneously, it is perhaps expected that they would be less functional, less accurate, or both in patients with ocular misalignment because 1 eye is off-axis. The Plusoptix A09 is not designed to provide a binocular refractive estimate in the presence of significant strabismus. In our series, the Plusoptix (used binocularly) obtained a reading on slightly fewer patients with strabismus than in those without strabismus and provided a refraction for 60.1% of these computer printouts. The Spot provided a reading (with 100% refraction) for 95.8% of those patients with strabismus, which was slightly more than those without strabismus. These findings suggest that the functionality of the Spot is not limited by strabismus. In addition, refractive estimates tended to show larger differences between the devices and cycloplegic retinoscopy for measures obtained from patients with strabismus than from those without strabismus. Although the ICCs remained high for both devices when compared with cycloplegic retinoscopy, there was a drop in the ICC for cylinder in patients with strabismus, especially notable for the Spot (0.600), suggesting the cylinder measurement is less reliable if the patient has strabismus.

The reproducibility of cycloplegic refraction has been found to be lower than that of autorefraction.[21] In our report, we found the photorefractors often correlated better with each other than the doctor's gold standard. It is possible that the photorefractors provide a truer reading, or it is possible that they have similar methodology and work with the same bias. We had 4 experienced pediatric ophthalmologists contributing to the cycloplegic refraction data, which may decrease one physician's influence on the overall data.

Autorefractors are used in ophthalmology offices for refraction estimates. Our findings suggest that refractions by the Spot and Plusoptix screeners are useful as a starting point for further evaluation using cycloplegic retinoscopy, particularly when prescribing glasses. Although the Plusoptix has been demonstrated to be useful in special needs patients,[5,13,22] the Spot was able to provide binocular refraction estimates in a larger percentage of patients, especially those with strabismus. However, although the Spot device provides a refractive estimate, it should be noted that it is not marketed as an autorefractor. In addition, the Plusoptix A09 offers a monocular option for further refraction refinement. Recently, both companies have released updated versions (Spot software update 2.016 and Plusoptix model S12), which are expected to improve results further.

In summary, both the Spot and the Plusoptix demonstrated overall good agreement of refractive data. In our setting of high-risk patients, the Spot provided binocular refractive data on a greater percentage of children, whereas the Plusoptix refractions agreed more closely with those of our pediatric ophthalmologists. Information about photo-refractor estimates may prove useful in establishing appropriate automated screening guidelines.

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TABLE 1

Patient Demographics and Spot and Plusoptix Vision Photoscreener Overview of Use

No. of patients	265
Age (y)	6.0 ± 3.4 (range, 1 to 16)
Sex, no. (%)	
Male	138 (52.1)
Female	127 (47.9)
Ethnicity, no. (%)	
White	133 (50.2)
Black	101 (38.1)
Other	31 (11.7)
Spot	
Reading obtained, no. (%)	250 (94.3)
Refraction estimate, no. (%)	250/250 (100)
Out of range, no.	7
Refractive error, no. (%)	
Myopic	4 (57.1)
Hyperopic	3 (42.9)
Plusoptix	
Reading obtained, no. (%)	250 (94.3)
Refraction estimate, no. (%)	188/250 (75.2)
Out of range, no.	19
Refractive error, no. (%)	
Myopic	4 (21.1)
Hyperopic	15 (78.9)

TABLE 2

Refraction Estimates of Patients With and Without Developmental Delay Using the Spot and Plusoptix Vision Photoscreeners

	Spot			Plusoptix		
Developmental Delay	**Reading Obtained**	**Reading Not Obtained**	**Refraction Estimate[a]**	**Reading Obtained**	**Reading Not Obtained**	**Refraction Estimate[a]**
No (n = 230)	217 (94.7)	13 (5.7)	217 (100)	215 (93.5)	15 (6.5)	159 (74.0)
Yes (n = 35)	33 (94.3)	2 (5.7)	33 (100)	35 (100)	0 (0)	29 (82.9)
Total (n = 265)	250 (94.3)	15 (5.7)	250 (100)	250 (94.3)	15 (5.7)	188 (75.2)

Data are value (%).

[a]If readings were obtained.

Am J Ophthalmol. Author manuscript; available in PMC 2015 November 01.

TABLE 3

Refraction Estimates of Patients With and Without a Diagnosis of Other Ocular Pathologic Features Using the Spot and Plusoptix Vision Photoscreeners

	Spot			Plusoptix		
Ocular Pathologic Features	**Reading Obtained**	**Reading Not Obtained**	**Refraction Estimate[a]**	**Reading Obtained**	**Reading Not Obtained**	**Refraction Estimate[a]**
No (n = 232)	222 (95.6)	10 (4.3)	222 (100)	221 (95.3)	11 (4.7)	174 (78.7)
Yes (n = 33)	28 (84.8)	5 (15.2)	28 (100)	26 (78.8)	7 (21.2)	14 (53.8)
Total (n = 265)	250 (94.3)	15 (5.7)	250 (100)	247 (93.2)	18 (6.8)	188 (76.1)

Data are number (%).

[a] If readings were obtained.

TABLE 4

Refraction Estimates of Patients With and Without a Diagnosis of Intermittent or Constant Strabismus Using the Spot and Plusoptix Vision Photoscreeners

	Spot			Plusoptix		
Strabismus Diagnosis	**Reading Obtained**	**Reading Not Obtained**	**Refraction Estimate[a]**	**Reading Obtained**	**Reading Not Obtained**	**Refraction Estimate[a]**
No (n = 169)	158 (93.5)	11 (6.5)	158 (100)	163 (96.4)	6 (3.6)	136 (83.4)
Yes (n = 96)	92 (95.8)	4 (4.2)	92 (100)	87 (90.6)	9 (9.4)	52 (59.8)
Total (n = 265)	250 (94.3)	15 (5.7)	250 (100)	250 (94.3)	15 (5.7)	188 (75.2)

Data are number (%).

[a]If readings were obtained.

TABLE 5

Mean Difference in Measurements of Sphere, Cylinder, Axis, and Spherical Equivalents (All Patients) Between the Spot and Plusoptix Vision Photoscreeners and Between the Photoscreeners and Cycloplegic Retinoscopy

	Sphere			Cylinder			Axis			Spherical Equivalent		
Comparison	**Mean (se)**	**95% CI**	***P* Value**	**Mean (se)**	**95% CI**	***P* Value**	**Mean (se)**	**95% CI**	***P* Value**	**Mean (se)**	**95% CI**	***P* Value**
Spot vs Plusoptix	0.71 (0.08)	0.53 to 0.89	<.001	−0.03 (0.04)	−0.11 to 0.05	.617	0.07 (2.43)	−5.77 to 5.63	.999	0.69 (0.07)	0.51 to 0.86	<.001
Spot vs Crx	−1.35 (0.07)	−1.51 to −1.19	<.001	0.36 (0.03)	0.29 to 0.43	<.001	3.57 (2.46)	−2.21 to 9.34	.316	−1.16 (0.07)	−1.31 to −1.00	<.001
Plusoptix vs Crx	−0.64 (0.08)	−0.82 to −0.46	<.001	0.32 (0.04)	0.24 to 0.41	<.001	3.50 (2.74)	−2.94 to 9.94	.409	−0.47 (0.07)	−0.64 to −0.30	<.001

CI = confidence interval; Crx = cycloplegic retinoscopy; se = standard error.

TABLE 6

All Patients Were Included in the Intraclass Correlation Coefficients to Estimate Interrater Reliability of Sphere, Cylinder, and Spherical Equivalent Data Between the Spot and Plusoptix Vision Photoscreeners and Between the Photoscreeners and Traditional Cycloplegic Retinoscopy

	Spot vs Plusoptix	Spot vs Crx	Plusoptix vs Crx
Sphere	0.826	0.860	0.904
Cylinder	0.767	0.716	0.805
Spherical equivalent	0.824	0.806	0.898

Crx = cycloplegic retinoscopy.

TABLE 7

Mean Differences in Measurements of Sphere, Cylinder, Axis, and Spherical Equivalents between Spot and Plusoptix Vision Photoscreeners and between the Photoscreeners and Traditional Cycloplegic Retinoscopy in Patients With and Without a Diagnosis of Intermittent or Constant Strabismus

	Sphere			Cylinder			Axis			Spherical Equivalent		
	Mean (se)	**95% CI**	***P* Value**	**Mean (se)**	**95% CI**	***P* Value**	**Mean (se)**	**95% CI**	***P* Value**	**Mean (se)**	**95% CI**	***P* Value**
With strabismus diagnosis												
Spot vs Plusoptix	0.80 (0.17)	0.40 to 1.20	<.001	0.10 (0.08)	−0.08 to 0.28	.385	3.68 (4.66)	−7.32 to 14.7	.890	0.75 (0.15)	0.39 to 1.12	< .001
Spot vs Crx	−1.91 (0.14)	−2.22 to −1.60	<.001	0.37 (0.06)	0.23 to 0.51	<.001	1.36 (4.19)	−8.55 to 11.3	.944	−1.71 (0.12)	−2.00 to −1.43	<.001
Plusoptix vs Crx	−1.11 (0.17)	−1.51 to −0.71	<.001	0.27 (0.08)	0.09 to 0.45	.001	−2.33 (5.06)	−14.3 to 9.62	.890	−0.96 (0.15)	−1.33 to −0.60	<.001
Without strabismus diagnosis												
Spot vs Plusoptix	0.63 (0.08)	0.46 to 0.80	<.001	−0.004 (0.04)	−0.095 to 0.088	.995	1.38 (2.85)	−5.33 to 8.08	.880	0.62 (0.07)	0.45 to 0.80	<.001
Spot vs Crx	−1.04 (0.07)	−1.20 to −0.88	<.001	0.35 (0.04)	0.27 to 0.43	<.001	6.13 (3.06)	−1.06 to 13.3	.113	−0.85 (0.07)	−1.01 to −0.70	<.001
Plusoptix vs Crx	−0.41 (0.07)	−0.58 to −0.24	<.001	0.34 (0.04)	0.25 to 0.43	<.001	4.76 (3.29)	−2.97 to 12.5	.318	−0.23 (0.07)	−0.40 to −0.06	.004

CI = confidence interval; Crx = cycloplegic retinoscopy; se = standard error.

TABLE 8

Patients With and Without a Diagnosis of Intermittent or Constant Strabismus Were Included in the Intraclass Correlation Coefficients to Estimate Interrater Reliability of Sphere, Cylinder, and Spherical Equivalent Data Between the Spot and Plusoptix Vision Photoscreeners and Between Photoscreeners and Traditional Cycloplegic Retinoscopy

	Spot vs Plusoptix	Spot vs Crx	Plusoptix vs Crx
With strabismus diagnosis			
Sphere	0.837	0.900	0.935
Cylinder	0.806	0.600	0.779
Spherical equivalent	0.866	0.914	0.951
Without strabismus diagnosis			
Sphere	0.814	0.806	0.813
Cylinder	0.819	0.780	0.817
Spherical equivalent	0.787	0.788	0.800

Crx = cycloplegic retinoscopy.