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A comparison of refraction measurements obtained by plusoptix A09 and autorefractometer in adult

Mustafa DURAN[1,*], Konuralp YAKAR[2], Emrah KAN[2]

[1]Department of Opthalmology, Hitit University, Erol Olçok Training and Research Hospital, Çorum, Türkiye
[2]Medicana International Samsun Hospital, Opthalmology Clinic, Samsun, Türkiye

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Abstract

To compare the refraction values obtained with the Plusoptix A09 photorefractometer and Topcon autorefractometer in adults. 230 eyes of 115 patients who had no eye disease other than refractive error were included in the study. Refraction measurements were made with the Plusoptix A09 photorefractometer and Topcon KR-8100P autorefractometer devices. Measurements were taken three times, and the averages were recorded. Median spherical, cylindrical, spherical equivalent, and cylindrical axis measurements obtained with both devices were statistically compared. Interdevice compatibility was evaluated with intraclass correlation coefficient (ICC) and Spearman correlation analysis. The median age of 115 patients was 37 years (range, 20-67); 50 (43.5%) were female, and 65 (56.5%) were male. The median spherical value obtained with Plusoptix A09 photorefractometer 0.50 D (range, -4.00-(3.25)), median cylindrical value -0.50 D (range, -2.00-(0.00)), spherical equivalent median 0.38 D (range, -4.00- (3.00)), the J0 power median was 0 (range, -1.00-(1.00)), and the J45 power median was 0 (range, -0.49-(0.37)). The median of the spherical value obtained by autorefractometer is 0.0 D (range, -3.75-(2.00)), the median of the cylindrical value is -0.50 D (range, -2.00-(0)), the median of the spherical equivalent is -0.25 D (range, -3.75- (1.75)), the J0 power median was 0 (range, -0.87-(0.98)), and the J45 power median was 0 (range, -0.59-(0.50)). There was a significant difference between spherical, cylindrical, and spherical equivalent measurements between devices. There was no significant difference between J0 and J45 measurements. Besides being used in childhood, the Plusoptix A09 photorefractometer can also be used as a fast and easy refraction measurement method, especially in physically or mentally handicapped adults with adjustment problems.

Keywords: Plusoptix A09, photorefractometer, refractive errors, autorefractometer

1. Introduction

Refractive errors are the leading cause of correctable visual impairment worldwide (1-2). Accurate measurement and treatment of refractive errors are essential in detecting and preventing amblyopia in children and eliminating asthenopic complaints in children and adults. Autorefractometers for refraction measurements have been widely used since the 1970s. (3)

Cycloplegic retinoscopy is the gold standard for detecting refractive errors. However, the fact that it requires experience and takes a long time limits its use (4). Measurement with photorefraction is a method developed for screening purposes; it is especially used to detect refractive errors in children and mentally and physically handicapped people. It has conveniences such as simultaneously taking measurements in both eyes and not having to contact the patient's head anywhere (5-7).

Plusoptix A09 photorefractor (Plusoptix GmbH, Nuernberg, Germany) is a non-invasive measurement instrument developed for children that measures rapid refraction from both eyes, pupil diameter, and interpupillary distance (8).

This study aimed to compare the measurements made with Plusoptix A09 in the adult population with the measurements made with the autorefractometer (Topcon desktop autorefractometer).

2. Materials and Methods

This prospective study was conducted at Hitit University's Erol Olçok training and research hospital in accordance with the Helsinki Declaration after obtaining written consent from patients and approval from the local ethics committee (2022-82). The study included 230 eyes from 115 patients who came to the department of ophthalmology for a refractive error examination.

Those who had ophthalmic surgery, ocular trauma, strabismus, nystagmus, cataract, corneal and retinal disorders were excluded from the study. Patients with systemic disease (excluding hypertension), using topical drugs, wearing contact lenses, or having refraction outside the measurement ranges of

*Correspondence: drmduran19@hotmail.com

the Plusoptix A09 device (-7 D / +5 D) were not included.

Measurements were taken with the Plusoptix A09 photorefractometer (Plusoptix GmbH, Nuernberg, Germany) device in a dark room approximately 1 meter from the patient. There is a smiley face on the camera on the device, and after pressing the start button, the smiley face automatically lights up and makes sounds that will attract the patient's attention. The device is moved back and forth until green circles around the pupils appear on the screen. Results are seen on the monitor and saved. This device can take measurements between -7.0 D and +5.0 D spherical and cylindrical values in 0.25 Diopter (D) increments. If the spherical equivalent is outside this range, the measured value is only displayed as 'Hypermetropia' or 'Myopia.'

All patients' refraction measurements were taken first with the Topcon KR-8100P autorefractometer (Topcon Corporation, Tokyo, Japan) and then with the Plusoptix A09 photorefractometer. The measurements were taken three times, and the averages were recorded. All patients underwent a detailed eye examination, including anterior and posterior segments. All measurements and examinations were performed by the same ophthalmologist (MD).

Median spherical, cylindrical, and spherical equivalent measurements obtained with both devices were recorded. Cylindrical axis measurements were statistically compared as Jackson cross-cylinder power values (J0 and J45). Spherical equivalent (SE)= Spherical + Cylinder/2 was calculated. J0= [(-Cylinder/2)* cos(2*axis)] for Jackson cross cylinder 0^0 and 45^0 axes, respectively; It was calculated using the formulas J45= [(-Cylinder/2)* sin(2*axis)].

2.1. Statistical analysis

In the data evaluation, compliance with the normal distribution was examined with the Kolmogorov-Smirnov test. Wilcoxon test was used to compare the measurement values according to the devices. Spearman correlation test and intraclass correlation coefficient (ICC) were used to evaluate the agreement between the measurements of the devices. For statistical significance, $p<0.05$ was considered significant. IBM SPSS V22 package program was used in all statistical analyzes.

3. Results

The median age of 115 patients included in the study was 37 years (range, 20-67); 50 (43.5%) were female, and 65 (56.5%) were male. The median spherical value obtained with Plusoptix A09 photorefractometer 0.50 D [range: -4.00-(3.25)], median cylindrical value -0.50 D [range: -2.00-(0.00)], SE median 0.38 D [range: -4.00- (3.00)], J0 power median was 0 [range: -1.00-(1.00)] and J45 power median was 0 [range: -0.49-(0.37)]. The median spherical value obtained with Topcon autorefractometer 0 D [range: -3.75-(2.00)], median cylindrical value -0.50 D [range: -2.00-(0.00)], SE median -0.25 D [range: -3.75- (1.75)], the J0 power median was 0 [range: -0.87-(0.98)] and the J45 power median was 0 [range: -0.59-(0.50)].

Table 1. Comprasion of measurements obtained with Topcon autorefractometer and Plusoptix A09 photorefractometer

	Autorefractometer			Plusoptix A09			
	median	min	max	median	min	max	p
S (D)	0.00	-3.75	2.00	0.50	-4.00	3.25	**<0.01**
C (D)	-0.50	-2.00	0.00	-0.50	-2.00	0.00	**<0.01**
SE (D)	-0.25	-3.75	1.75	0.38	-4.00	3.00	**<0.01**
J0	0.00	-0.87	0.98	0.00	-1.00	1.00	0.05
J45	0.00	-0.59	0.50	0.00	-0.49	0.37	0.58

S: spherical, C: cylindrical, SE: sferical equivalent, J0: Jackson cross-cylinder power at 0º , J45: Jackson cross-cylinder power at 45º , D: diopter, min: minimum, max: maximum

There was a statistically significant difference in spherical, cylindrical, and spherical equivalent measurements between the two devices ($p<0.05$). There was no significant difference in J0 and J45 power measurements (respectively, $p=0.05$, $p=0.58$) (Table 1).

Table 2. Comparison of the measurements of the two devices with the Spearman correlation and Intraclass correlation coefficients (ICC) of the measurements between the devices

Autorefractometer- Plusoptix	ρ	ICC	95% CI
S (D)	0.769	0.921	0.898 to 0.939
C (D)	0.716	0.862	0.821 to 0.894
SE (D)	0.777	0.928	0.906 to 0.944
J0	0.876	0.939	0.921 to 0.953
J45	0.732	0.862	0.822 to 0.894

S: spherical, C: cylindrical, SE: spherical equivalent, J0: Jackson cross-cylinder power at 0º, J45: Jackson cross-cylinder power at 45º, ρ: Spearman correlation coefficient, ICC: Intraclass corelation coefficient, 95% CI: 95 % confidence interval

Table 2 shows the correlation of measurements between devices. Spearman correlation coefficient values between autorefractometer and Plusoptix A09 for spherical, cylindrical, SE, J0, and J45 power values are positive and significant (respectively, ρ=0.769, ρ=0.716, ρ=0.777, ρ=0.876, ρ=0.732, for all p<0.001) relationship was found. Intraclass correlation coefficients (ICC) values were spherical, cylindrical, spherical equivalent, J0, and J45 power values (respectively, 0.921, 0.862, 0.928, 0.939, 0.862, for all p<0.001). A strong positive correlation existed between all measurements made with the autorefractometer and Plusoptix A09. Figure 1 shows the compatibility of both devices with the Blant Altman graph (Fig. 1).

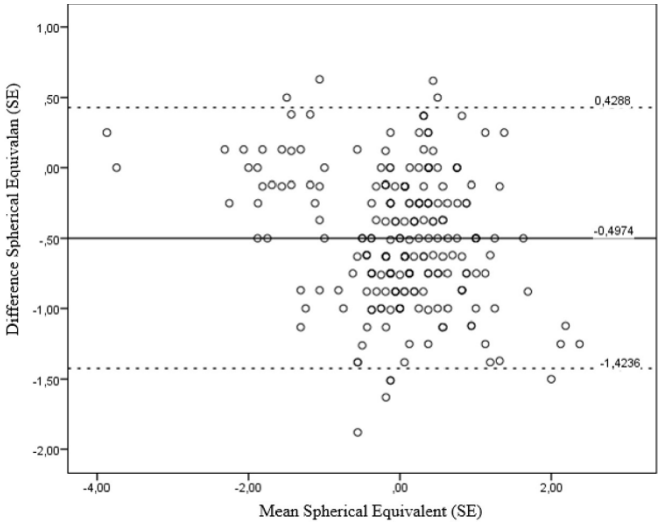

Fig. 1. Bland–Altman plots illustrating the differences and means of SE values obtained with the autorefractometer and Plusoptix photorefractometer

4. Discussion

In this study, we compared Plusoptix A09 and Topcon autorefractometer measurements in adults; Although there was a significant difference between spherical, cylindrical, and SE measurements, there was no significant difference between J0 and J45 power values. It was determined that the Plusoptix A09 device measured the median spherical and SE values more hyperopia than the autorefractometer.

Allen et al., in their study on 50 adults aged 16-61 years, found that the values measured by photorefractometer (Powerrefraktor; Plusoptix, Hillsboro Beach, FL) were 0.32 D more hyperopic than the values measured by Nidek autorefractometer (Nidek AR600-A, Nidek, Japan) (7). Demirel et al., in their study of 127 adults with a mean age of 33.3 years and 110 children with a mean age of 8.06 years, found the measurements taken with Plusoptix S08 0.25 D more myopic than the measurements taken with the Topcon autorefractometer. In addition, they showed that adults had an average of 0.50 D more hyperopia (8). Abrahamsson et al. measured 150 children between 6 months and five years with a photorefractometer (Powerrefractor, Reutlingen, Germany) and autorefractometer (Topcon, RM A2000, Mondal, Sweden). As a result, they found that the photorefractometer measures 0.42 D more hyperopia (6). Arıcı et al., in their study of 21 children with an average age of 9.95 years and 24 adults with an average age of 23.46 years, took the photorefractometer Plusoptix S08 and autorefractometer (Potec PRK-6000, Daejeon, Korea) measurements. And mean spherical values of 0.49 D in children and 0.63 D in adults were found to be hyperopic (9). In their study, Acar et al. took measurements with Plusoptix A09 and an autorefractometer, which included 272 adults with a mean age of 38.85 years. They found the measurements taken by the photorefractometer to be 0.72 D more hyperopic (10).

In our study, similar to the above studies, we found that the median spherical value was 0.54 D, and the median SE was 0.63 D more hyperopic measurement in adults in the measurements taken with Plusoptix A09. This was attributed to the fact that the photorefractometer stimulates accommodation less and is less affected by accommodation (11,12).

In their studies on cylindrical values, Arıcı et al. measured the photorefractometer Plusoptix S08 and autorefractometer (Potec PRK-6000, Daejeon, Korea) in their study. They found no significant difference between the two groups in terms of cylindrical values and cylindrical axis (9). Güler et al. showed no significant difference between cylindrical and cylindrical axis values in a study in which they compared 25 adults with a mean age of 30.01 years and 25 pediatric patients with a mean age of 11.08 years (12). In their study with 64 patients aged 2-19 years, Kıyak Yılmaz et al. showed no difference between cylindrical power and cylindrical axis measurements, similar to other studies (13). Anayol et al. found no difference between the groups in terms of cylindrical power in measurements taken with a photorefractometer and autorefractometer. Still, they found a statistically significant difference in Jackson cross-cylinder measurements at 0-degree axis (14).

In our study, unlike the studies above, there was a significant difference between the two devices in terms of cylindrical values (p<0.01). However, there was no difference between the median values. Cylindrical axis measurements were evaluated by converting them to J0 and J45 power values, and there was no significant difference between the two devices (p=0.05, p=0.58, respectively).

Photorefraction measurements have advantages such as being used in infants, children, and maladjusted patients, lack of physical contact, and fast and binocular measurement. In addition, measurements cannot be taken with the Plusoptix A09 device in cases where the pupil diameter is 3 mm below and 8 mm above and when the refraction is outside the limits of -7.0 D and +5.0 D.

One of the limitations of our study is the inability to compare the gold standard cycloplegic refraction measurements. However, the fact that Plusoptix A09 could not measure very small and very large pupils led us to obtain measurements without cycloplegia. Secondly, since healthy

adult individuals were evaluated in our study, we do not know how effective it is in adults with physical or mental disabilities.

As a result, although there was a significant difference between spherical, cylindrical, and SE measurements in the measurements made with both devices, it was observed that there was a strong positive correlation between the measurements. Considering that it measures more hyperopia, the Plusoptix A09 photorefractometer can be used as a fast and easy-to-apply refraction measurement method in adults with compliance problems, physically or mentally handicapped, as well as in children.

Conflict of interest

The authors declared no conflict of interest.

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None to declare.

Authors' contributions

Concept: M.D., K.Y., E.K., Design: M.D., K.Y., E.K., Data Collection or Processing: M.D., E.K., Analysis or Interpretation: M.D., K.Y., Literature Search: M.D., E.K., Writing: M.D., Y.K.

Ethical Statement

Approval was obtained from Hitit University Clinical Research Ethics Committee, the study started. The ethics committee decision date is 14/09/2022 and the number of ethical committee decisions is 2022-82.

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