

Objective measurement of refractive errors: Comparison of plusoptix s08 with a standard autorefractometer

Objektif refraksiyon kusuru ölçümü: Plusoptix s08 ile standart bir otorefraktometrenin karşılaştırılması

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ABSTRACT

Objective: Comparison of Plusoptix S08 with a standart autorefractometer (Topcon RM 8000B) in children and adults.

Methods: 220 eyes of 110 children, with a mean age of 8.06 ± 2.89 years old were examined to compare non-cycloplegic measurements provided by Plusoptix S08 and cycloplegic measurements provided by Topcon RM-8000B autorefractometer. In addition, 254 eyes of 127 adults, with a mean age of 33.3 ± 13.36 years old were examined to compare non-cycloplegic refractive measurements provided by Plusoptix S08 and Topcon RM 8000B autorefractometer. All measurements were repeated three times. Median sphere, cylinder, spherical equivalent and cylindrical axes as Jackson cross cylinder power measurements (J0 and J45) were compared statistically.

Results: The median differences in spheres, cylinders, spherical equivalents, J0 and J45 powers were -0.25 D ($P < 0.001$), -0.25 D ($P < 0.001$), -0.25 D ($P < 0.001$), -0.02 ($P = 0.038$), 0.00 ($P = 0.395$), in children, respectively. These values were 0.50 ($P < 0.001$), 0.00 ($P < 0.001$), 0.375 ($P < 0.001$), 0.03 ($P = 0.053$), 0.79 ($P = 0.081$), in adults, respectively.

Conclusion: Plusoptix S08 has a myopic misspelled according to Topcon-RM8000B autorefractometer in children. However, measurements provided with Plusoptix S08 were more hyperopic than those with Topcon RM-8000B autorefractometer in adults. *J Clin Exp Invest* 2013; 4 (1): 40-46

Key words: Refractive errors, autorefraction, photorefraction, plusoptix S08

ÖZET

Amaç: Çocuklarda ve erişkinlerdeki refraksiyon kusuru ölçümünde, Plusoptix S08 ile standart bir oto refraktometre (Topcon RM 8000B) ölçümlerinin karşılaştırılması.

Yöntemler: Yaş ortalaması 8.06 ± 2.89 yıl olan 110 çocuğun 220 gözü Plusoptix S08 ile sikloplejisiz olarak, Topcon RM-8000B otorefraktometresiyle sikloplejili olarak ölçüldü. Elde edilen değerler karşılaştırıldı. Ayrıca, yaş ortalaması $33,3 \pm 13,4$ olan 127 yetişkinin 254 gözü, Plusoptix S08 ve Topcon RM 8000B otorefraktometre ile sikloplejisiz olarak ölçülerek, bu ölçümlerin karşılaştırması yapıldı. Tüm ölçümler üç kez tekrarlandı. Ortalama sferik, silindirik, sferik ekivalan ve silindirik aks değerleri istatistiksel olarak karşılaştırıldı.

Bulgular: Ortalama sferik, silindirik, sferik ekivalan, J0 ve J45 güçleri çocuklarda sırasıyla: -0.25 D ($p < 0.001$), -0.25 D ($p < 0.001$), -0.25 D ($p < 0.001$), -0.02 ($p = 0.038$), 0.00 ($p = 0.395$) bulundu. Erişkinlerde ise 0.50 ($p < 0.001$), 0.00 ($p < 0.001$), 0.375 ($p < 0.001$), 0.03 ($p = 0.053$), 0.79 ($p = 0.081$) olarak ölçüldü.

Sonuç: Topcon-RM8000B otorefraktometreye göre Plusoptix S08 çocuklarda daha miyopik bir ölçüm yapıyordu. Ancak yetişkinlerdeki Plusoptix S08 ölçümleri daha hipermetropik izlenmekteydi.

Anahtar kelimeler: Refraksiyon kusuru, plusoptix S08, fotorefraksiyon, otorefraksiyon

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INTRODUCTION

Cycloplegic retinoscopy and subjective refraction is still the gold standard for measuring refractive error in children. But, cycloplegia usage take more time and causes patient discomfort. Therefore, autorefractometers have become widely used to determine the objective refractive status. Modern autorefractometers are standard clinical instruments that generally use Scheiner's double pinhole principle (e.g. Topcon RM-8000B, Topcon Corporation- Tokyo, Japan) or retinoscopy based infrared video refraction method (e.g. Plusoptix S08 - Plusoptix GmbH, Nuremberg, Germany).¹⁻³ In addition, few autorefractometers work on slightly different principals. Such as, Grand Seiko/Shin-Nippon (Grand Seiko Co., Ltd., Fukuyama, Japan) works on the principal of imaging the magnification of a shape reflected from the retina and Canon R-1 (Canon Inc., Tokyo, Japan) works on position of the peak intensity of light as a lens passed through three beams of light reflected off the retina.⁴ Currently, some videorefractors were presented by manufacturers as non-cycloplegic autorefractometers called as photoscreener.

Photorefraction is described as retinoscopy based videorefraction method to determine refractive state from a distance of a meter or more without cycloplegia. Photorefraction method is preferred by Kennedy and Schmidt et al to screen children or children who would not otherwise cooperate with objective pediatric vision screening methods; however its reliability and accuracy has been questioned. Other commercial devices that have used this measurement principle include: iScreen Vision, MTI PS-100 Photoscreener, PlusOptix S08 Auto-Refractor/Photoscreener (Previous models were PowerRefractor and Plusoptix S04, current version is S09), Right Medical Retinomax Autorefractor, Visiscreen OSS-C, Welch Allyn SureSight Autorefractor, Fortune Optical VRB-100 videophotorefractor.⁵⁻⁸

Various studies suggest that non-cycloplegic photorefraction has reasonable accuracy and repeatability compared with cycloplegic retinoscopy and subjective refraction. However, in a study it was demonstrated that accommodation may not be completely neutralized.³ It may be especially important in children who have high accommodative reserve.

PlusoptiX S08 (Plusoptix GmbH, Nuremberg, Germany) is a new non-cycloplegic infrared videoretinoscopy based photorefractor. It can measure the refractive status binocularly, which facilitates the detection of anisometropia, at a distance of approximately 1 meter in dim room. Refractive status is determined by assessing the distribution of the

reflected light from retina across the pupil. According to its user manual, it has maximum spherical and cylindrical range of -7.00 to +5.00 D.⁹⁻¹¹

Instead of easy usage and fast measurement technique, there were also some difficulties experienced in the measurement of especially children in standart autorefractometers. For this reason, some new devices have been developed recently, which can measure from a distance, such as Plusoptix S08.

There are many studies about comparison of photoscreeners, autorefractometers and/or gold standard retinoscopy. In previous studies, the measurements of autorefractometers were compared with retinoscopy. Though their measurement were not found exactly correct, found compatible with retinoscopy.^{1,3,12-14} Based on this information, we just aimed to investigate the correlation of measurements provided by Plusoptix S08 and a standard autorefractor (it was Topcon RM-8000B in our clinic), not to investigate the accuracy of Plusoptix S08. The main question was "May Plusoptix S08 considered as a standard autorefractor?"

METHODS

Two hundred twenty eyes of 110 children (47 male and 63 female), with a mean age of 8.06 (SD= 2.89) years (range from 1 to 13 years, median 8.0 years) were examined. At first, non-cycloplegic measurements with Plusoptix S08 were performed, and then cycloplegic refraction was obtained with Topcon RM 8000B autorefractometer.

Non-cycloplegic measurements with Plusoptix S08 and Topcon RM 8000B autorefractometer of 254 eyes of 127 adults (66 male and 61 female), with a mean age of age 33.3 (SD= 13.36) years (range from 17 to 70 years, median 30.0 years) were performed.

Approval to conduct the study was obtained from local ethic committee of Inonu University. All patients underwent a complete ophthalmologic examination to minimize the measurement errors, subjects with ocular pathologies (strabismus, amblyopia, significant refractive error or history of ocular surgery) and abnormal binocular vision were excluded from the analyses. Measurements were repeated three times with new calibrated equipments by only one ophthalmologist. Cycloplegia was induced by 2 drops of cyclopentolate 1% administered with 5 minutes intervals to both eyes. After an hour, if pupillary constriction was still present, a third drop was administered. Cycloplegia was considered complete if the pupil dilated 6 mm and pupillary constriction was absent.^{15,16}

Median of spherical values (S), spherical equivalent (SE= sphere + [cylinder/2]), cylindrical values (C) and axes were statistically compared. But assessing the variance in the astigmatic component poses a problem in conventional form, mean sphere, cylinder and axis component were converted into a vector representation for analysis described by Thibos et al: (spherical equivalent= sphere + [cylinder/2]); Jackson cross cylinder at axis 0° (J0) with power J0= (-2[cylinder/2. Cos [2.axis]]); Jackson cross cylinder at axis 45° (J45) with power J45= (-2[cylinder/2. sin [2.axis]].¹⁷

The normality of our data was tested with Shapiro-Wilks test and because the normality assumption

was not satisfied Wilcoxon signed rank test was used for the comparison of Plusoptix S08 and Topcon RM 8000B measurements. The significance level (p value) is chosen to be less than 0.05. The comparisons between measures of spherical and cylindrical values were presented graphically using Bland-Altman plots.

RESULTS

The median (with minimum and maximum range) of sphere, cylinder, spherical equivalent (SE), J0 and J45 power measurements for Plusoptix S08 and Topcon RM 8000B autorefractor were shown in Table 1 and Table 2.

Table 1. Noncycloplegic measurements with Plusoptix S08 and cycloplegic measurements with Topcon RM8000B autorefractometer in children. Min= Minimum value, Max= Maximum value, D= Dioptri

Measurements of adults	PLUSOPTIX S08 Median (min / max)	TOPCON RM 8000B Median (min / max)	P*
Spherical (D)	+0.50 (-4.00 / +3.50)	0.00 (-3.75 / +2.50)	<0.001
Cylindrical (D)	-0.50 (-5.50 / 0.00)	-0.50 (-4.50 / 0.00)	<0.001
Spherical Equivalent	0.125 (-5.25 / +3.25)	-0.25 (-5.37 / +2.12)	<0.001
0° Jackson	-0.02 (-1.44 / +1.86)	-0.05 (-2.11 / + 1.23)	0.053
45° Jackson	-0.04 (-2.64 / + 1.93)	-0.83 (-2.16 / +1.30)	0.081

Table 2. Noncycloplegic measurements with Plusoptix S08 and noncycloplegic measurements with Topcon RM8000B autorefractometer in adults. Min= Minimum value, Max= Maximum value, D= Dioptri

Measurements of children	PLUSOPTIX S08 Median (min / max)	TOPCON RM 8000B Median (min / max)	P
Spherical (D)	+1.25 (-5.75 / +4.75)	+1.50 (-4.25 / +5.50)	0.001
Cylindrical (D)	-0.75 (-5.75 / 0.00)	-0.50 (-4.75 / 0.00)	<0.001
Spherical Equivalent	+1.00 (-6.00 / +4.63)	+1.25 (-4.75 / +4.63)	<0.001
0° Jackson	0.01 (-2.75 / +2.35)	0.03 (-1.99 / +1.81)	0.038
45° Jackson	-0.03 (-2.38 / +1.80)	-0.03 (-2.10 / +2.28)	0.395

Sphere

The median spherical value was +1.25 (ranging, -5.75 / +4.75) dioptri (D) with Plusoptix S08 and 1.50 (ranging, -4.25 / +5.50) D with Topcon autorefractometer in children. Plusoptix S08 has a myopic tendency in children. The median spherical values were +0.50 (ranging, -4.00 / +3.50) D with Plusoptix S08 and 0.00 (ranging, -3.75 / +2.50) D with Topcon autorefractometer in adults. Measurements provided with Plusoptix S08 were more hyperopic in adults. There were statistically significant differences in children and adults ($p < 0.001$) (Figure 1 and 2).

Cylinder

In children, the median cylindrical values were -0.75 (ranging, -5.75 / 0.00) D with Plusoptix S08 and -0.50 (ranging, -4.75 / 0.00) D with topcon autorefractometer.

In adults, the median cylindrical value was -0.50 (ranging, -5.50 / 0.00) D with Plusoptix S08 and -0.50 (ranging, -4.50 / 0.00) D with Topcon autorefractometer. There were statistically significant differences in these variables in both groups ($p < 0.001$) (Figure 3 and 4).

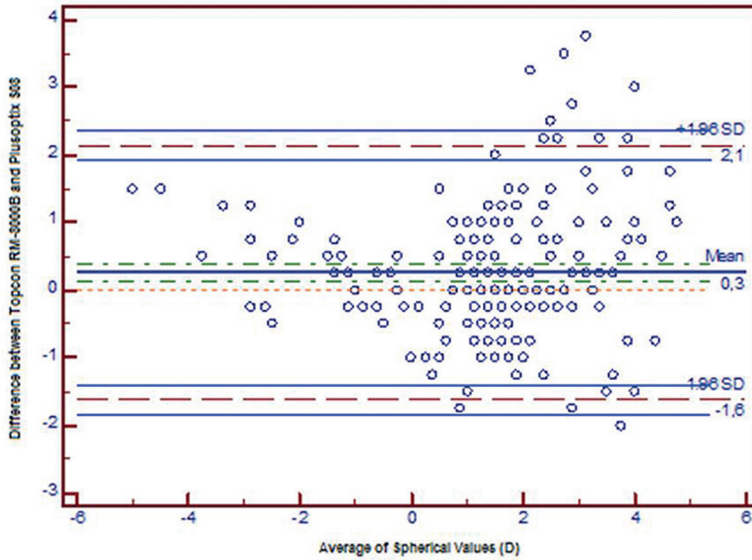


Figure 1. Difference between Topcon RM-8000B and Plusoptix S08 in Spheric components (D) using Bland-Altman plot in children.

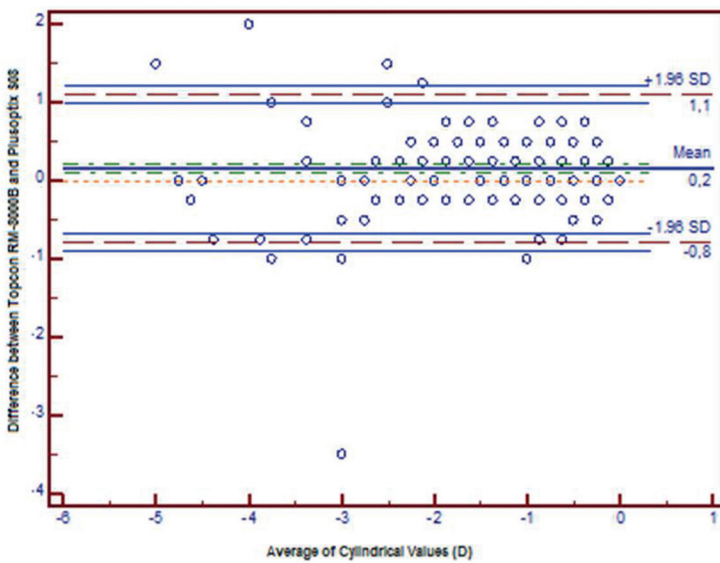


Figure 2. Difference between Topcon RM-8000B and Plusoptix S08 in Cylindrical components (D) using Bland-Altman plot in children.

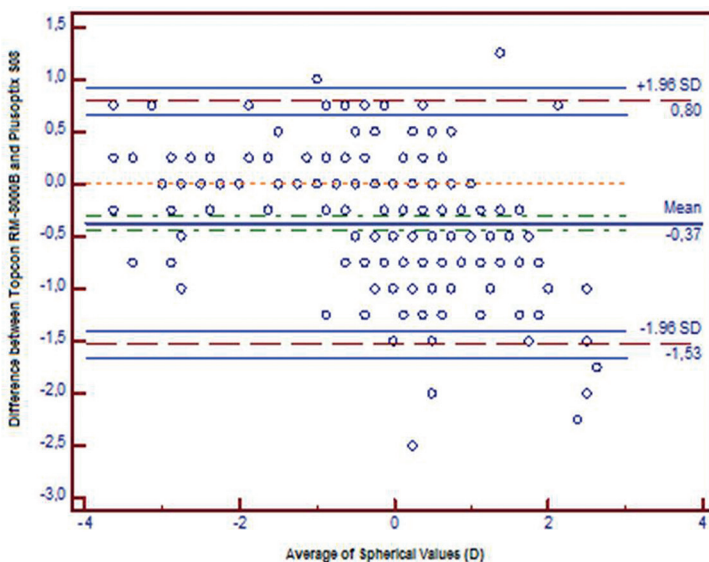


Figure 3. Difference between Topcon RM-8000B and Plusoptix S08 in Spheric components (D) using Bland-Altman plot in adults.

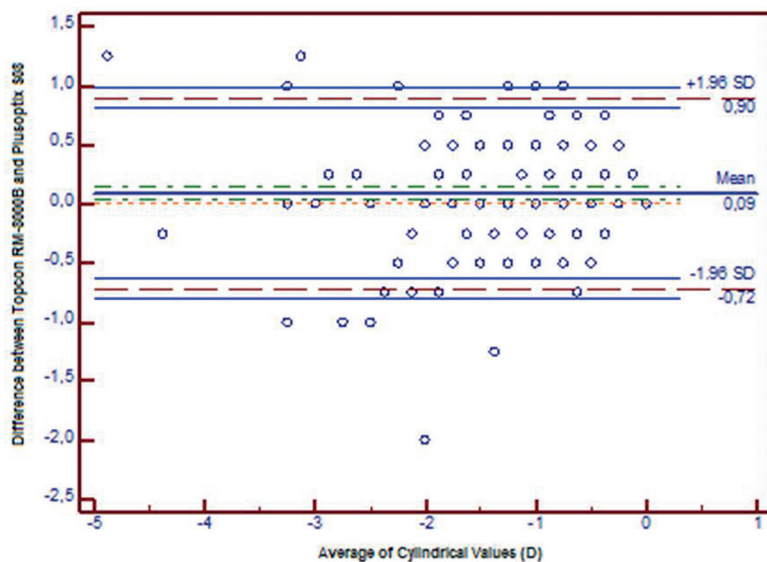


Figure 4. Difference between Topcon RM-8000B and Plusoptix S08 in Cylindrical components (D) using Bland-Altman plot in adults.

Spherical Equivalent

In children: The median SE values were +1.00 (ranging, -6.00 / +4.63) D with Plusoptix S08 and +1.25 (ranging, -4.75 / +4.63) D with Topcon autorefractometer.

In adults: The median SE was +0.125 (ranging, -5.25 / +3.25) D with Plusoptix S08 and -0.25 (ranging, -5.37 / +1.12) D with Topcon autorefractometer.

Statistically significant differences were observed ($p < 0.001$) in both groups.

J0 and J 45 powers

In children: The median J0 powers were -0.01 (ranging, -2.75 / +2.35) D with Plusoptix S08 and 0.03 (ranging, -1.99 / +1.81) D with Topcon autorefractometer. The median J45 powers were -0.03 (ranging, -2.38 / +1.80) D with Plusoptix S08 and -0.03 (ranging, -2.10 / +2.28) D with Topcon autorefractometer.

In adults: The median J0 powers were -0.02 (ranging, -1.44 / +1.86) D with Plusoptix S08 and -0.05 (ranging, -2.11 / +1.23) D with Topcon autorefractometer. The median J45 powers were -0.04 (ranging, -2.64 / +1.93) D with Plusoptix S08 and -0.83 (ranging, -2.16 / +1.30) D with Topcon autorefractometer.

Although, in terms of J0 power, statistically significant difference was observed in children ($p = 0.038$), no difference was observed in adults ($p = 0.353$). Moreover, in terms of J45 power, no significant difference was noticed in children ($p = 0.395$) or adults ($p = 0.081$).

DISCUSSION

Cycloplegic retinoscopy and subjective refraction is still the gold standard for measuring refractive error in children. But autorefractometers have become widely used to measure of refractive status. Major advantages of Plusoptix S08 photorefractometer when compared to autorefractometers are that it can be performed at a distance and it provides simultaneous measurements of both eyes therefore; it is especially suitable for infants or non-cooperative patients and pediatric vision screen. Major disadvantages of photorefractors are its limited ability to measure range and questionable repeatability and accuracy.^{3,12,16}

In the literature, we have seen few studies designed to compare the measurements Plusoptix S08 and an autorefractometer in children and adults.¹³⁻²¹ Aim of the study was to evaluate if Plusoptix S08 could be considered as an autorefractometer or not.

We found that, Plusoptix S08 had a myopic misspell in children (-0.25 D) but it showed hyperopic results (+0.50 D) in adults; both results were statistically significant. Similar to spherical values, SE were also observed a slight myopic tendency (-0.25 D) in children while hyperopic tendency in adults (+0.375). In addition, cylindrical values measured with Plusoptix S08 were more negative in both groups. While cylindrical values measured by both devices were not statistically compatible with each other; all Jackson cross cylinder powers except J0 power in children were compatible.

Allen et al. was reported no significant difference between the previous model of Plusoptix S08 called PowerRefractor and Nidek AR 600-A autore-

fractor measurements in adults[18]. Choi et al. compared the PowerRefractor to a modern autorefractor (Nidek AR800) and the results showed good agreement between autorefractor and Power-Refractor in adults. However in children aged 3-6 years; the PowerRefractor gave slightly more hyperopic readings than the autorefractor.¹⁹

In contrast to our results, in a study which compare PowerRefractor with Shin-Nippon SRW-5000 autorefractometer, Hunt et al identified that Power-Refractor results were more negative than SRW-5000 in non-cycloplegic adults. As a result of their study, PowerRefractor was suggested as a useful objective screening instrument.²⁰

To evaluate the viability of the PowerRefractor as a screening tool, the data provided by the Power-Refractor and an autorefractor or retinoscopy (Topcon RM-A2000) were compared for 150 children aged from 6 months to 5 years. Abrahamsson et al declared 1D difference in spherical equivalent measurements between the Powerrefractor and Topcon RM-A2000 in 142 children. In addition, the Power-Refractor was reported insufficient in clinical situation for estimating the amount and axis of astigmatism.²¹

In two different studies of Matta et al., Plusoptix S04 was also reported as an effective screening tool, because it was found a useful tool for the detection of amblyopia risk factors and showed a high sensitivity of 98.9% and specificity of 96.1%.^{12,22}

Paff et al. evaluated the performance of a hand held autorefractor and Plusoptix S08 in measuring refractive errors as a vision screener by comparing them with cycloplegic retinoscopy (CR) of 200 children. When compared to CR, the Plusoptix S08 showed a mean difference of -1.13 ± 1.25 D for spherical equivalent (SE) and -0.23 ± 0.53 D for the cylinder; after cycloplegia -2.11 ± 1.64 D for SE and -0.06 ± 0.47 D for the cylinder were measured. They concluded that, Plusoptix S08 has high sensitivity for the detection of myopia, astigmatism and anisometropia compared to cycloplegic retinoscopy; however, when used without cycloplegia, hyperopia is underestimated.⁹

Arıcı et al. compared the refractive errors measured with Plusoptix S08 photorefractometer, Nidek ARK-30 hand-held autorefractometer and Potec PRK-6000 autorefractometer in school-age children and adult population.²³ They found statistically significant difference in spherical power and spherical equivalent measured by the three devices ($p < 0.05$), but there was no significant difference in cylindrical values ($p = 0.641$, $p = 0.431$, respectively) and

Jackson cross cylinder powers at 0° and 45° axis ($p > 0.05$) in both groups.

Consequently, we observed statistically significant difference between the measurements of Plusoptix S08 and a standard autorefractometer. On the other hand, it should also be indicated about ophthalmologic use of PlusoptixS08 that, it is a good guide for the measurement of refractive errors in children and non-cooperative people, but inaccurate for prescribing lenses.

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