Medical and Research Publications
International Open Access

Research Article **Journal of MAR Ophthalmology (Volume 5 Issue 6)**

Clinical Accuracy of Autorefraction in Adult Ethiopian Population

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Received Date: May 23, 2023

Published Date: June 01, 2023

Abstract

Purpose: *The purpose of this study was to compare the accuracy of the Zeiss Visuref 100 Autorefractor using subjective refraction as a reference*

Methods: *one hundred ten patients aged 16 to 74 years with total eye of 220 underwent autorefraction followed by subjective refraction on the same day by a single clinician. Both eyes of each participants were included in the analysis.*

Results*: A clinically significant spherical equivalent difference was observed between the autorefraction and subjective refraction. Bland-Altman analysis revealed that the 95% limits of agreement between the autorefraction and subjective refraction range between -1.30 to +1.50 diopter.*

Conclusions: *Although autorefractor is a useful clinical tool as a starting point in refraction due to its clinically significant difference with subjective refraction it doesn't replace the later and therefore shouldn't be used alone.*

Introduction

Refractive errors are the most common ocular problem affecting all age groups. They are regarded as issues with public health. According to a recent WHO research, refractive errors account for 43% of visual impairments and are the second cause of visual loss worldwide as 43% of visual impairments are attributed to refractive errors.**[**1**]** In sub-Saharan Africa, the prevalence of refractive error and visual impairment due to refractive error was 12.6% and 3.4%, respectively.

Subjective refraction, retinoscopy, and autorefraction can be employed to evaluate the refractive error. Although there are alternatives to autorefraction, they may be time-consuming and occasionally wrong. In large-scale vision screening programs, autorefraction could be a beneficial component, particularly in resource-constrained areas like Ethiopia. Autorefraction enables health professionals to easily assess refractive error.**[**2**]**

Autorefractors provide the speed and precision needed for quick patient assessments in high-volume tertiary eye care settings. It could be a helpful element of extensive vision screening programs in public health outreach efforts, particularly in countries with low resources. **[**2**]**

About the accuracy of autorefractors in adults, there is a paucity of information worldwide. As far as the researcher is aware, there are no statistics on the accuracy of autorefractors in our nation. This research was performed to evaluate the reliability of autorefractors relative to subjective refraction. In this study, the Zeiss Visuref 100 Autorefractor's ability to provide a reasonably accurate estimate of refractive error was assessed.

Materials and Methods

Ethics

Ethical approval was obtained from institutional review boards at the St. Paul's hospital millennium medical college. Written informed consent was obtained from all participants.

Study design

This was a cross-sectional study whereby 110 patients attending ophthalmology department at St. Paul's hospital millennium medical college, were enrolled. Subjects were included only if they had vision 6/60 or better. All of the refraction procedures were performed under noncycloplegic conditions. Autorefraction was performed first, followed by subjective refraction. the Zeiss Visuref 100 Autorefractor was used since it was readily aviliable. If the patient's previous prescription was known it was used as the starting point for subjective refraction. Subjective refraction was conducted with trial frame with vertex distance kept to a minimum. Cylindrical power and axis were refined using a 0.25-diopter Jackson cross cylinder. Refraction of each eye was performed monocularly followed by binocular balancing. The highest plus sphere and the lowest minus results that provided the best acuity and comfortable vision were considered as the end point. Subjective refraction was recorded to the closest 0.25 diopter. To minimize the risk of bias, autorefraction was conducted by the same examiner. The autorefractor was calibrated daily according to the manufacturer's guidelines. Participants were instructed to look at the internal fixation target.

Data analysis

Refraction measurements were transformed using Fourier vector decomposition to spherical equivalent and Jackson cross cylinder scalar values using the following formulas, where S = sphere, C = cylinder.

$$SE = S + \frac{C}{2}$$

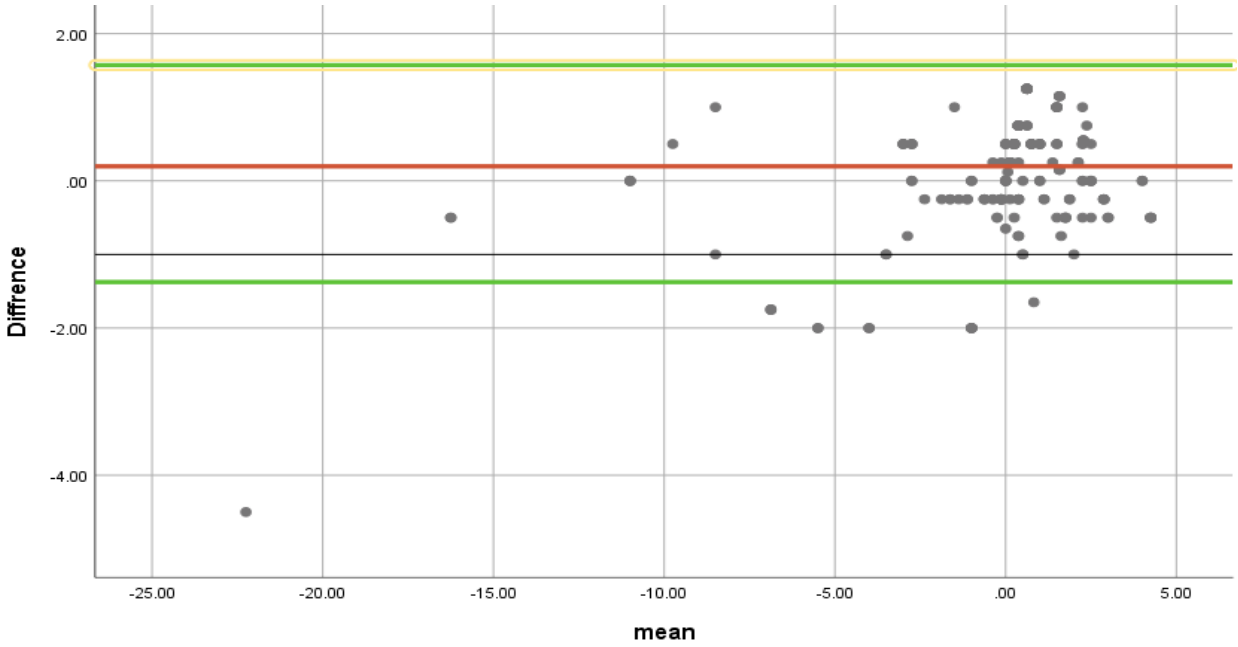
Bland-Altman plots of the spherical equivalent was used to demonstrate the limits of agreement between autorefraction and subjective refraction values, whereas mean differences were assessed using SPSS v26. The diagnostic accuracy of the autorefractor was assessed assuming subjective refraction as the reference standard. Subjective refraction was chosen as the reference standard because it is currently the test generally used to dispense eyeglassesses.

Results

In October 2022, study participants signed up. Both tests were completed on a total of 220 eyes from 110 individuals. No adverse events occurred during testing. Eyes with the best corrected visual acuity of 6/60 or worse were excluded. Approximately 50.1 % of participants were female and the average age of participants was 48 years(range 16 to 74 years). Subjectively assessed mean spherical equivalent refractive errors ranged from -20.00 to +4.00.

Analysis

Bland-Alman plots comparing measurements of spherical equivalent between autorefractor and subjective refraction are shown in Fig. Significant differences were observed in spherical equivalent findings of the autorefraction as compared to the subjective refraction. The 95% limits of agreement between the autorefraction and subjective refraction were -1.30 to +1.50 diopter(Fig). The autorefractor produced spherical equivalent estimates that were on average more myopic than subjective refraction(Table).



Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Subjective refraction of the eye	196	24.50	-20.00	4.50	-.2973	3.29885
Autorefraction result	197	28.50	-24.50	4.00	-.2711	3.60635
Valid N (listwise)	196					

Discussion

In this investigation, the autorefractor produced slightly more myopic measurements of spherical equivalent compared to subjective refraction. The limits of agreement measured in this study indicate that 95% of the time, a measurement from an autorefractor will be within approximately 2.80 diopters of the measurement obtained from subjective refraction. Prior published studies have reported limits of agreement within 0.78-1.00 diopter.**[**3-5**]** However, these previous studies were done in a relatively low degree of refractive error therefore this might be one reason why the limit of agreement is low.

It's unclear what role autorefraction plays in adult vision screening programs. Unlike children where refractive error represents the most common cause of visual impairment in adults, other diseases like cataracts and diabetic retinopathy play a major role. Therefore, autorefraction may not be helpful in those diseases. Complete eye examinations with a slit lamp would be ideal to be able to capture these pathologies. Less expensive instruments like the pinhole occluder are sensitive and specific for the detection of refractive error, so it may not be necessary to include an expensive electronic device in screening programs **[**6,7**]**. On the other hand, older adults sometimes have difficulty navigating the pinhole test, whereas the autorefractor does not require much cooperation to provide a result.

The results of the present study suggests that autorefractors don't reach a level of diagnostic accuracy since there is a clinically significant difference when compared to subjective refraction but it can still be used as a starting point for patients who have both autorefraction and subjective refraction.

Even though we used subjective refraction as the benchmark in this investigation, it is not a perfect comparator**[**8**]**. For example, a study that compared subjective refraction performed by two different clinicians found a 95% limit of agreement of 0.78 D **[**3-5**]**. Moreover, subjective refraction required the cooperation and participation of the test taker.

Strengths of the study include a relatively large sample of eyes, and an older population not frequently studied in similar studies. Moreover, unlike previous studies which used a narrow range of refractive errors in their study, we included all patients who fulfilled the inclusion criteria.

It must be acknowledged that this study has some limitations. First, we concur with previous authors that using subjective refraction as a reference has potential drawbacks because measurements may vary depending on whether one or multiple medical professionals perform the subjective refraction. To reduce healthcare provider bias, we assessed subjective refraction by a single practitioner. The autorefractors were old versions, and we lacked access to modern models, which is another drawback.

Third, the subjective refraction may have been biased because the researcher was aware of the participant's prior prescription. However, the researcher made sure to follow a uniform procedure for every participant, with the goal being to get the greatest possible acuity and comfortable vision with the new prescription as the endpoint.

In conclusion, the 95% limit of agreement between the subjective refraction and objective refraction doesn't seem sufficient for the sole use of autorefraction in refractive error screening in community outreach programs. However, autorefraction may still be used as a quick method to identify patients who would benefit from spectacles, or as a starting point for a patient to compare several pairs of spectacles.

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