ESTIMATION OF REFRACTIVE ERRORS: A COMPARATIVE STUDY BETWEEN STREAK RETINOSCOPY AND AUTOREFRACTOMETER

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ABSTRACT

BACKGROUND

Retinoscopy helps in accurate measurements of accommodative response, while an autorefractometer can only help in predicting the accommodative system activation especially in children in whom accommodation is very active. It is of utmost importance to understand as to which of the two methods of objective correction is better accepted by the patients. We wanted to compare the accuracy of retinoscopy and autorefraction in acceptance of subjective correction.

METHODS

A total of 250 patients in the age group of 10-40 years, with refractive errors were studied by streak retinoscopy and auto refractometer. These tests were followed by subjective refraction or post mydriatic test as applicable, both monocular as well as binocular, until best corrected visual acuity was achieved.

RESULTS

The spherical power estimated by retinoscopy and AR was accepted by 87.6% and 43.4% of the eyes respectively while 12.4% and 56.6% of the eyes respectively didn't accept it. The cylindrical power on the other hand, as estimated by retinoscopy and AR was accepted by 57% and 78.6% of the eyes respectively. The axis on retinoscopy and AR was accepted by 60.6% and 72.8% of the eyes respectively.

CONCLUSIONS

Retinoscopy is a reliable starting point for refraction; however, autorefraction values are important in order to accurately prescribe cylindrical correction.

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BACKGROUND

Globally the principle causes of visual impairment are uncorrected refractive errors (43%), cataract (33%), glaucoma (2%), age related macular degeneration, diabetic retinopathy, trachoma and corneal opacities (1%) and undetermined causes (18%).[1] Refractive error is a treatable cause of visual impairment, with correction of significant refractive error being one of the top five priorities of Vision 2020.[2,3]

Blurred vision due to refractive error can be alleviated in most cases by neutralizing the refractive error with spectacles, contact lenses or refractive surgery. Before administering any such treatment to the patient, it is imperative to have a precise and accurate method of objectively calculating a subject's refractive error and assessing what is best accepted by them.

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Refractive errors can be estimated objectively and subjectively. Clinically these methods include ophthalmoscopy, retinoscopy and refractometry.[4] Retinoscopy is the most generally satisfactory and accurate method for objective determination of the refraction. It has been noticed that although auto refractometer (AR) provides a fast, accurate and reliable measurement, in children it often yields a more myopia result due to excessive accommodation.[5]

Accommodation interferes with accurate diagnosis of the latent refractive errors especially in children in whom accommodation is very active. Retinoscopy helps in accurate measurements of accommodative response, while an autorefractometer helps in predicting the accommodative system activation especially in children.[5] Automatic refractors have become more important recently because of the busy clinical schedule of ophthalmologists and increasing faith of patients in sophisticated mechanical devices.[6]

India is densely populated country, and thus, a faster technique to calculate refractive errors easily, has created a niche in the day to day practices of the ophthalmic surgeon. It, however, is of utmost importance to understand which of the two methods of objective correction is better accepted by the patients, before deciding on the technique to be used as a standard one. Hence, the aim of the present study was

to compare the accuracy of retinoscopy and autorefraction in acceptance of subjective correction.

METHODS

In this prospective study a total of 250 patients in the age group of 10-40 years, with refractive errors, presenting to the Ophthalmology Out Patient Department were studied over a period of two years.

Inclusion Criteria

- Patients in age group of 10-40 years.
- Patients with defective vision who improve with pinhole.
- Patients with asthenopic symptoms.
- Patients with defective vision who are already using spectacle correction.
- Patients with clear optical media.
- Consented individuals

Exclusion criteria

- Patients with retinal diseases.
- Patients who have undergone refractive surgeries.

The Tropicamide (0.8%) + phenylephrine (0.5%) eye drops were used for examination of patients. The patients were examined using torch, auto refractometer, retinoscope, direct ophthalmoscope, Snellen's drum, Jaeger's chart and Slit lamp.

Both the eyes of 250 patients, that is, 500 eyes, were evaluated in this study. Visual acuity was examined using Snellen's chart. Near vision was examined using Jaeger's chart. The auto refraction was done using a TOPCON KR8800 auto refractor. Three values were taken, the average of which was calculated. Retinoscopy was done using a Heine Beta 200 Self illuminating streak retinoscope, after dilatation of pupil with mydriatic, at 2/3rd metre distance, in a dark room using distance fixation target and loose trial lenses. Both retinoscopy and AR were done by same person and were done by postgraduate student. These tests were followed by subjective refraction or post mydriatic test as applicable, both monocular as well as binocular, until best corrected visual acuity was achieved. Subjective refraction was done on next day.

A routine ophthalmic examination of both eyes and fundoscopic examination after dilatation of pupil with mydriatic was done using Heine Beta 200 ophthalmoscope to rule out any other ocular co-morbidities before prescribing spectacles.

Statistical Analysis

Data were entered using Microsoft excel 2007 and analysed using SPSS version 22. Categorical variables were reported as proportion. Continuous data were described as means (standard deviation) depending on the distribution of data.

RESULTS

In our study, the majority of patients in age group 31-40 years had hypermetropia (41 subjects) with male to female ratio of 1.33:1 while, majority of patients in age group 10-20 had myopia (108 subjects) with male to female ratio of 1.71:1. Out of 176 patients, majority of patients had simple myopia (92.04%) followed by pathological myopia (7.96%).

It was observed that of all the eyes examined on retinoscopy, 51% had myopia while 49% of the eyes had hypermetropia. Of the total sample of eyes, 70.2% had myopic and 29.8% had hypermetropic cylinders.

Type of Error on Retinoscopy	Spherical Power		Cylindrical Power	
	No. of Patients	Percent (%)	No. of Patients	Percent (%)
Myopia	255	51	351	70.2
Hypermetropia	245	49.0	149	29.8
Total	**500**	**100**	**500**	**100**

Table 1. Type of Refractive Error as Determined by Retinoscopy

It was observed that of all the eyes examined on AR, 51.8% of them had myopia spherical powers while 48.2% of the eyes had hypermetropia spherical powers. Of the total sample, 72% had myopic cylinders and 28% eyes had hypermetropic cylinders .Difference in acceptance of AR is more for myopia.

Type of Error on Auto-Refractometer	Spherical Power		Cylindrical Power	
	No. of Patients	Percent (%)	No. of Patients	Percent (%)
Myopia	259	51.8	360	72.0
Hypermetropia	241	48.2	140	28
Total	**500**	**100**	**500**	**100**

Table 2. Type of Refractive Error on Auto Refractometer

Uncorrected visual acuity of 6/9, 6/12, 6/18, 6/24, 6/36 and 6/60 was observed in 28 patients (5.6%), 78 patients (15.6%), 146 patients (29.2%), 121 patients (24.2%), 75 patients (15%) and 38 patients (7.6%) of the tested eyes respectively and in 14 patients (2.8%) eyes the vision was recorded as <6/60.

It was seen that out of all the eyes examined, 51.4% of them accepted myopic spherical powers while 48.6% of the eyes accepted hypermetropic spherical powers. Of the total study samples, 71.6% had accepted myopic cylinders, 28.4% accepted hypermetropic cylinders.

Type of Error on Subjective Acceptance	Spherical Power		Cylindrical Power	
	No. of Patients	Percent (%)	No. of Patients	Percent (%)
Myopia	257	51.4	358	71.6
Hypermetropia	243	48.6	142	28.4
Total	**500**	**100**	**500**	**100**

Table 3. Type of Refractive Error on Subjective Acceptance of Correction

In the present study, the spherical power estimated by retinoscopy was subjectively accepted by 87.6% of the eyes while 12.4% of the eyes didn't accept it. The cylindrical power on the other hand, as estimated by retinoscopy was accepted by 57% of the eyes and the axis on retinoscopy was accepted by 60.6% of the eyes. The retinoscopy estimation of cylinder power and axis was not accepted by 43% and 39.4% of the eyes respectively.

	Accepted	Not Accepted	Total
	No. of Patients (%)	No. of Patients (%)	No. of Patients (%)
Spherical	438 (87.6%)	62 (12.4%)	500 (100%)
Cylindrical	285 (57%)	215 (43%)	500 (100%)
Axis	303 (60.6%)	197 (39.4%)	500 (100%)

Table 4. Pattern of Acceptance of Retinoscopy Findings

	Accepted	Not Accepted	Total
	No. of Patients (%)	No. of Patients (%)	No. of Patients (%)
Spherical	217 (43.4%)	283 (56.6%)	500 (100%)
Cylindrical	393 (78.6%)	107 (21.4%)	500 (100%)
Axis	364 (72.8%)	136 (27.2%)	500 (100%)

Table 5. Pattern of Acceptance of AR Findings

The spherical power as estimated by AR was accepted as it is subjectively by 43.4% of the eyes while 56.6% of the eyes didn't accept it. The cylindrical power on the other hand estimated by AR was accepted by 78.6% of the eyes and axis on AR was accepted by 72.8% of the eyes. The AR estimation of cylinder power and axis was not accepted by 21.4% and 27.2% of the eyes respectively.

	<3D	>3D	Total
	No. of Patients (%)	No. of Patients (%)	No. of Patients (%)
Retinoscopy	426(85.2%)	74 (14.8%)	500 (100%)
AR	393 (78.6%)	107 (21.4%)	500 (100%)
Subjective acceptance	429 (85.8%)	71 (14.2%)	500 (100%)

Table 6. Degree of Ametropia on Retinoscopy, AR and Subjective Acceptance

It was found that, 85.2% of the eyes had ametropia of less than 3D spherical power and 14.8% of the eyes were found to have ametropia of more than 3D spherical power by retinoscopy. 78.6% of the eyes had ametropia of less than 3D spherical power and 21.4% of the eyes were found to have ametropia of more than 3D spherical power by AR. 85.8% of the eyes had ametropia of less than 3D spherical power and 14.2% of the eyes were found to have ametropia of more than 3D spherical power by subjective acceptance.

Cylindrical Axis Acceptance	No. of Patients (%)
Retinoscopy	146 (29.2)
AR	164 (32.8)
Both Equally	160 (32)
None	30 (06)
Total	**500(100)**

Table 7. Pattern of Axis Acceptance on Retinoscopy and AR

DISCUSSION

Objective determination of refractive status is a prerequisite for the subjective adjustment of refraction prior to prescription of glasses. Refractometry finds wide use in current ophthalmic practices, and is being used extensively for objective determination of refraction. During the last few years automated refractometry has gained tremendous popularity. This trend is supported by the possibility of delegating automated refractometry to assistant medical personnel.

Topcon KR8800 autorefractometer, which was used in present study, can measure, hyperopia of 0 to + 22D with a 0.25D step display, switchable to 0.12D, and myopia of 0 to -25D, with a 0.25D step display which is switchable to 0.12D. With respect to corneal features, it measures astigmatism of 0 to 10D with a 0.25D step display, which is switchable to 0.12D. Axial angle can be measured from 0 to 180°, with 1° step display which is switchable to 5° step display. In retinoscopy, the range depends on the available lenses in the trial set.

In the present study, the spherical power estimated by retinoscopy was subjectively accepted by 87.6% of the eyes while 12.4% of the eyes didn't accept it. The cylindrical power on the other hand, as estimated by retinoscopy was accepted by 57% of the eyes and the axis on retinoscopy was accepted by 60.6% of the eyes. The retinoscopy estimation of cylinder power and axis was not accepted by 43% and 39.4% of the eyes respectively.

The spherical power as estimated by AR was accepted as it is subjectively by 43.4% of the eyes while 56.6% of the eyes didn't accept it. The cylindrical power on the other hand estimated by AR was accepted by 78.6% of the eyes and axis on AR was accepted by 72.8% of the eyes. The AR estimation of cylinder power and axis was not accepted by 21.4% and 27.2% of the eyes respectively.

Consistent with the results of our study, in a study by Vilaseca et al where differences in Spherical Equivalent between the double-pass system and the other techniques were studied, retinoscopy was found to give more hypermetropic values than the double-pass system -0.51 ± 0.50D and also the subjective refraction -0.23 ± 0.50D while, more myopic values were yielded by means of autorefraction- 0.24 ± 0.49D.[6]

Similar to the results of our study, in a study by Jorge et al, the results obtained for the value of the spherical equivalent revealed that the values obtained by autorefractometer were more negative in the myopia and

less positive in the hypermetropia as compared to retinoscopy and subjective refraction.[7]

Similar to the results of our study, a multitude of other studies in which different models of autorefractor were evaluated, also showed the same tendency of the autorefractor to underestimate the value of the refractive error in relation to the other two methods. Also in the study by Jorge et al, the retinoscopy and subjective refraction confidence interval was one-half that of the autorefractor and subjective refraction, and they concluded that, retinoscopy could be half a dioptre more precise than autorefraction, in the estimation of an objective start point for noncycloplegic refraction.[7] In our study, the mean SE with retinoscopy was 1.64 ± 1.26 (95% CI -0.88 to 4.16 D), with AR was 1.84 ± 1.36 (95% CI -0.88 to 4.56 D) and subjectively, it was 1.70 ± 1.29 (95% CI -0.88 to 4.28 D). In the study by Jorge et al, 44.3% accepted the sphere power obtained by AR and 74.5% accepted the retinoscopy estimates better. Regarding cylinder power 89.6% accepted AR values, while 96.9% accepted retinoscopy values. Also, with reference to cylinder axis, 55.2% accepted AR while, 65.6% accepted retinoscopy values. In this study, the spherical power acceptance correlates with our study, but the cylindrical power acceptance and axis of cylinder acceptance does not correlate with our study.

In another study conducted on astigmatic powers in adults, prior to refractive surgery, it was concluded that non-cycloplegic retinoscopy was the least reliable method with respect to cylindrical refractive powers as well as their axis.[8] Our study was done with cycloplegia, and it revealed that retinoscopy is a relatively less reliable modality for estimating cylinder axis as well as power.

In our study, out of the tested eyes, 375 eyes i.e. 75% improved to 6/6, 76 eyes i.e. 15.2% to 6/9, 35 eyes i.e.7% to 6/12 and only 14 eyes i.e. 2.8% were able to read the 6/18 line on the Snellen's chart on testing vision with a pin hole. In our study, it was observed that 450 eyes i.e. 90% of eyes improved visual acuity to 6/6, 20 eyes i.e. 4% improved to 6/9 and 6/18 and only 10 eyes i.e. 2% improved to 6/12.

Though AR produces a fast, repeatable measurement of refractive error, its validity is as important as its efficiency. Thus, it is important to assess its agreement with correction accepted by the patient. In present day ophthalmic practice, ARs are also widely used in optometric and ophthalmic research e.g., to examine refractive error development, accommodative responses, and comparison of pre- to-postoperative condition.

Guirao and Williams suggested that the possible source of disagreement between the various methods of refraction like retinoscopy, autorefractometer and subjective refraction is the presence of higher- order aberrations in the human eye. An important reason for this is that the pupil size may be larger while performing retinoscopy or AR, as compared to the size of the pupil during subjective correction. The larger the amount of higher- order aberrations present, the greater will be the amount of disagreement between various methods of refraction.[9]

Consistent with the results of our study, Uras R et al study results showed that for the mean spherical equivalent (M), the autorefractor yields more negative values. The result also showed that when performed by an experienced clinician, retinoscopy was more accurate than automatic refraction. Retinoscopy gives a better starting point to non-cycloplegic refraction.[10]

Thus, our study revealed that the agreement displayed by both retinoscopy and AR with respect to acceptance by patients, is similar. However, higher agreement was found with retinoscopy for the spherical power component, while AR was slightly better for cylindrical component of refractive error as well as axis of cylinder.

CONCLUSIONS

Retinoscopy is a reliable starting point for refraction; however, autorefraction values are important in order to accurately prescribe cylindrical correction. Autorefractometer is an invaluable aid for screening large number of cases in busy ophthalmological clinics. But it should not replace the art of clinical refraction testing and should be used with great caution especially in younger patients in whom accommodation is more active because of which true extent of hypermetropia may be unrevealed. Manual retinoscopy is still the most accurate technique to estimate refractive status especially in children and gives better starting point for refraction.

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