Original Article

# Refractive changes during off-the-axis retinoscopy in myopia

*Ritesh Kumar Chaurasiya*

**Purpose:** To analyze the refractive shift during off-the-axis retinoscopy under cycloplegic drugs in myopic patients during ocular examination. **Methods:** Prospective cross-sectional study was carried out among 10 myopic patients having refractive errors of −3.00 D or less. All the subjects underwent cycloplegic refraction by a single examiner at 0°, 10°, and 20°. Descriptive data were analyzed as mean and standard deviation. Paired t-test was used to compare the mean differences between on-axis (0°) and off-axis (10° and 20°) retinoscopy. **Result:** The mean spherical equivalent refraction of 10 myopic patients showed an increase in myopic shift with approximately 7% and 18% for 10° and 20° of eccentricity, respectively. Similarly, the mean spherical equivalent measure on axis (0°) and off axis (10° and 20°) were -2.5495, −2.737, and −3.0265, respectively. The mean spherical equivalent differences between on-axis (0°) and off-axis (10° and 20°) showed statistically significant differences with $P < 0.05$. **Conclusion:** This study concluded that a greater degree of eccentricity will induce a greater amount of errors in retinoscopy.

**Key words:** Eccentricity, myopic shift, retinoscopy

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Retinoscopy is an objective method to measure refractive error during ocular examination. It is also used for making therapeutic decisions. Different textbooks suggest that on-axis retinoscopy is necessary for accurate measurement of a patient's refractive error.[1-3] There are some studies suggesting the effect of off-axis retinoscopy on the determination of refractive error in a clinical setting.[4-6] Compared with ocular components such as cornea and crystalline lens, the axial length is also considered as the preliminary factor for refractive error.[7] In a study, the correlation showed higher axial length when compared with other ocular structures (0.76).[7] Similarly, the studies on non-cycloplegic examination[4,5,8] and use of schematic eyes[9] with off-axis retinoscopy state that great attention on peripheral refraction is required in refractive error correction. Additionally, several studies on off-axis retinoscopy of peripheral refraction at 20° or more along the horizontal meridian indicated clinically insignificant changes in refraction.[4,5] The purpose of this study was to analyze the refractive shift of off-axis retinoscopy up to 20° from the point of fixation in myopic patients during clinical examination.

## Methods

A cross-sectional study of 10 participants having a refractive error of −3.00 DS or less underwent cycloplegic refraction in the right eye on the visual axis (i.e., 0°) and at 10° and 20° off the visual axis in the nasal side. Adult patients were included in the study to ensure minimal errors during target fixation at the time of retinoscopy. All the subjects were having normal ocular findings except for the presence of refractive error.

A drop of cyclopentolate 1%, tropicamide 1%, and phenylephrine 2.5% was instilled every 5 min three times in the right eye of the patient 40 min before the procedure. The cycloplegic drug was administered to paralyze the accommodation and hence minimizing the errors.

The patients were given a fixation light at 0°, 10°, and 20° at the distance of 40 cm from the patient's left eye, and the position of the targets was toward the left side of the left eye of the subjects.

The participants were then instructed to move their left eyes toward the fixation target till the retinoscopy was undergoing. One target was illuminated at a time and stabilization of the fixation was ensured by one of the investigators. The same working distance of 50 cm was used and all retinoscopies were performed by a single examiner to avoid inter-examiner bias. The subjects were given break after retinoscopy to avoid muscle strain of the patient during retinoscopy at each time.

Statistical analysis was performed using SPSS software (IBM SPSS, version 23; IBM Corp., Armonk, NY, USA). Descriptive analysis was done to summarize the result in mean and standard deviation. Paired t-test was conducted to compare the mean differences between on-axis (0°) and off-axis (10° and 20°) retinoscopy. Statistical significance was considered if $P$ was less than 0.05.

## Results

Of 10 subjects enrolled in the study, the male: female ratio was 1.5:1. The mean spherical equivalent refraction of 10

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myopic subjects showed an increase in myopic shift with approximately 7% and 18% at 10° and 20° of eccentricity, respectively [Fig. 1].

Similarly, the mean spherical equivalent measure on-axis (0°) and off-axis (10° and 20°) retinoscopy were −2.5495, −2.737, and −3.0265, respectively [Fig. 2]. The graph showed a linear increment in the myopia as the retinoscopy was aimed off-axis by the examiner. Using paired t-test to compare the mean value of spherical equivalent between on-axis and off-axis retinoscopy, the mean values had significant differences between 0° and 10° ($t$ = 7.414, $P$ < 0.05), between 10° and 20° ($t$ = 9.996, $P$ < 0.05), and between 0° and 20° ($t$ = 10.304, $P$ < 0.05).

Similarly, the spherical component of the myopic subjects also showed an increment in the myopic shift due to an increase in the eccentricity [Fig. 3]. The mean spherical component measured on the axis and each position off the axis were −2.11, −2.3619, and −2.612, respectively.

## Discussion

On-axis retinoscopy during ocular examination is very important to correct refractive error. It provides important data for the management of refractive error, amblyopia, and strabismus. In a study, it had been stated that retinoscopy will be very difficult if the patient is either uncooperative or does not have a steady fixation.[7] Several textbooks of optics have also concluded that minimal error is obtained during on-axis retinoscopy as compared with off-axis retinoscopy. A similar study stated that "the smaller the eccentricity, the smaller will be error."[3] The main purpose of the present study was to determine the changes in refraction value on off-axis retinoscopy under cycloplegia during correcting refractive error. The result of present study confirms that the error during retinoscopy increases as the eccentricity increases. An average myopic shift of 7% and 18% for 10° and 20° of eccentricity was noted in the spherical equivalent. This confirms that the patients were having peripheral induced myopia, which is characteristic of oblate shape globe.[6]

Jackson *et al*.[10] also found a similar finding where 5% of myopic shift was noted per degree of eccentricity and suggested characteristics of oblate shape globe. Similarly, Tay *et al*.[11] found that the errors in refraction during off-axis retinoscopy were not statistically significant ($P$ = 0.068; paired t-test) when compared with on-axis retinoscopy. The present study found significant differences between each degree in off-axis retinoscopy. There are three components in the eye that determine the refractive power of the eye: axial length, corneal curvature, and power of crystalline. Corneal curvature flattens from apex to limbus and becomes less spherical.[12-14] This flattening in the cornea induces a hyperopic refractive shift.[12-14] The results of the present study did not correlate with the findings reported by Bogan *et al*.[14] Similarly, the axial length of the normal eye is longest on the visual axis and off-axis retinoscopy along shorter axial length should also induce hyperopic refractive error.[15] Therefore, the induced myopic shift in our study is not likely due to changes in corneal curvature and axial length in our research subjects.[16] However, in several other studies, it has been stated that there will be a myopic shift if the light rays pass through the lens

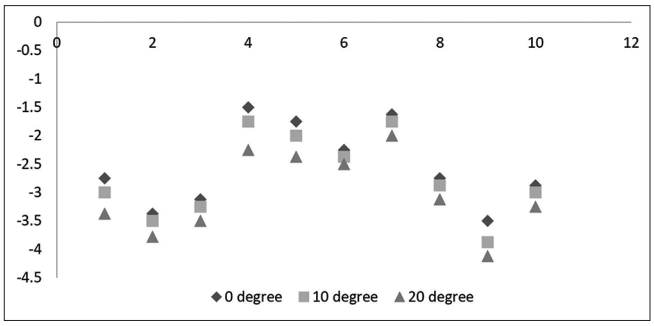


**Figure 1:** Individual patient data suggesting increasing myopic shift in spherical equivalent with increasing degree in off-axis retinoscopy

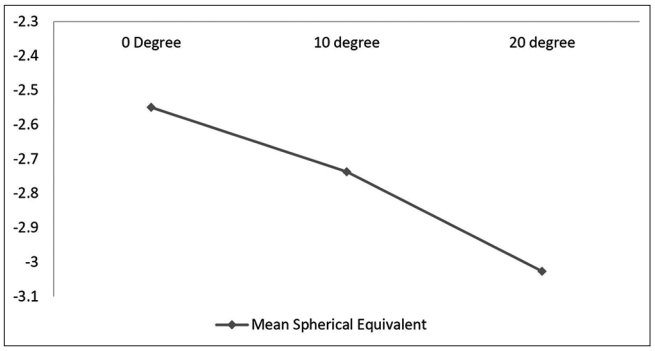


**Figure 2:** Mean spherical equivalent on the axis and each point off the axis showing increasing myopic shift with an increase in eccentricity

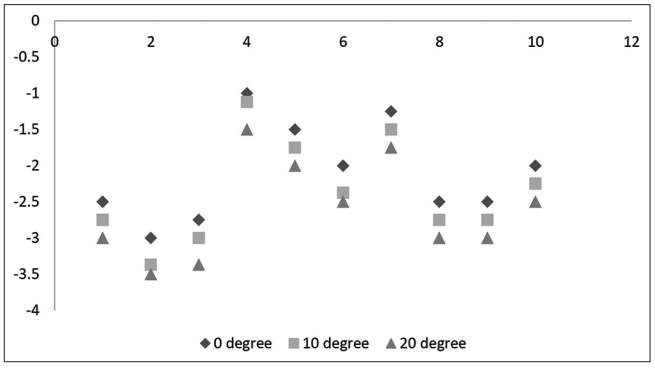


**Figure 3:** Spherical component of the refraction for each off-axis position showing increasing myopia with increasing eccentricity

obliquely. A similar finding was noted in our study during off-axis retinoscopy. Lastly, in a study, it was observed that increased myopic shift occurs if the intraocular lens is tilted *in vitro* 7°, 11°, or 15° by using a Gull strand model eye.[12] Similar findings were noted in our study.

The present study also showed that a myopic shift occurs within 20° eccentricity from the visual axis. These findings do not correlate with Querios *et al*.[17] who reported that myopic shift occur after 25° of eccentricity from the visual axis.

The findings from the present study also revealed that the errors during off-axis retinoscopy will not be clinically significant when the refractive error of the patient is small. However, these changes suggest that eccentricity will have greater significance when the refractive error will be high.

## Conclusion

The result of our study shows that with the increase in the eccentricity, the refractive power also changes, which can result in either under-correction or over-correction of refractive error. This study concludes that the reliability of retinoscopy will be better during on the axis measurement and that the examiner should always perform retinoscopy along the visual axis of the patient with minimal accommodative effort.

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### Conflicts of interest

There are no conflicts of interest.

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