Objective autorefraction in posterior chamber pseudophakia

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Abstract
Automated refraction with the Canon RK-1 Autoref keratometer was evaluated in 110 eyes (110 patients) six to eight weeks after they had undergone extracapsular cataract extraction with posterior chamber intraocular lens implantation and achieved a best corrected visual acuity of at least 6/12. Autorefraction readings were obtained in 100 (91%) of these eyes. The agreement between autorefraction and clinical refraction data was 98% for spherical equivalence <0·51 dioptres (D), 95% for sphere power <0·51D, 94% for cylinder power <0·51D, and 85% for cylinder axis <11°. Autorefraction can provide acceptably accurate postoperative refraction values in pseudophakic eyes.

Autorefractors (AR) are being increasingly used in busy ophthalmology clinics because they can be operated by a nurse or technician,1 are much quicker than manual refraction,1,2 and are readily accepted by most patients.1 Recent experience indicates that objective autorefraction provides reliable and valid preliminary refraction data,1,47 especially in subjects who cannot accommodate owing to aphakia2 10 or cycloplegia.

Intraocular lenses (IOL) can interfere with the accuracy of objective ARs,1 9 10 by scattering the measuring infrared beam and increasing ‘noise’.10 17 Attempts have been made to overcome this problem in modern ARs by providing an ‘IOL setting’ which can be switched on to improve the signal-to-noise ratio in the recording system while refracting pseudophakes. We evaluated the use of one such instrument, the Canon RK-1 Autoref keratometer, in patients with posterior chamber IOLs prior to its introduction into routine clinical use.

Patients and methods

INSTRUMENT
The Canon RK-1 Autoref keratometer combines both automated refraction and keratometry in one instrument (Fig 1). In the autorefraction mode infrared rays are projected on to the patient’s retina and the reflected illumination is detected by an array of photodetectors. This is based on the Scheiner double pinhole principle, which enables the AR to determine the ocular refraction in three meridians. The instrument then computes and displays the objective ocular refraction in terms of sphere, cylinder, and axis corrected for a vertex distance of 12 mm.

The AR covers a pupillary area of 2·9 mm and can measure up to 15 dioptre (D) sphere, 7 D cylinder, and axis between 1° and 180° in increments of 0·12 D or 1°. It has an in-built autofogging mechanism consisting of a photo-target which is supposed to relax completely the patients’ accommodation. An IOL setting is present which can be switched on to improve the accuracy of refraction in pseudophakes.

The measurement of refraction is made in 0·05 second, which is facilitated by sensor assisted alignment and focusing over a built-in television monitor. The iris of the eye to be measured is clearly focused, the ring target is aligned with the pupil, and the measurement button pressed to display the objective ocular refraction. Any number of such measurements may be performed either in the single or continuous mode. The refractive data displayed can be printed out if necessary. If more than three measurements have been performed the computer automatically calculates and prints the most reliable or ‘standard’ values from the last three to five data.

Low reliability of the measurement due to movement of the eye during testing, postoperative deformation of the cornea or iris, and eccentricity of the IOL are indicated by a special ‘reliability mark’ (henceforth referred to as ‘less reliable’ data). Improper alignment, droopy eyelids, or insufficient pupillary size require appropriate remedial action when the signal error is displayed on the television monitor, as valid readings cannot otherwise be obtained. More detailed operating and maintenance information is available in the accompanying instrument manual.

Figure 1 The Canon RK-1 Autoref keratometer.

PATIENTS AND EYES
This was a prospective study carried out between
six and eight weeks following extracapsular cataract extraction with the implantation of a posterior chamber IOL. When both the eyes of a patient fulfilled the above criteria, only the right eye was studied. Of the 129 such patients seen consecutively in the eye clinic 19 were excluded because their studied eyes did not attain a best corrected visual acuity of at least 6/12. Valid AR values could not be obtained for various reasons in 10 patients, leaving 100 eyes of 100 patients which were analysed.

METHODS
All the refractions, both clinical as well as on the autorefractor, were carried out by the same examiner (PSR) without the use of either mydriatics or cycloglegics. Objective clinical refraction (streak retinoscopy) was first carried out, followed by subjective verification to achieve the best possible visual acuity. Autorefraction was then performed, and a series of three readings were obtained from each eye. The ‘standard’ refractive value in the AR printout data (categorised into reliable and less reliable data) was then compared with the final prescription based on clinical refraction for degree of agreement.

STATISTICAL ANALYSIS
The statistical significance of the difference between the less reliable (indicated by the reliability mark) and reliable autorefractive data was evaluated by (1) χ² test on the number of eyes (patients) in the two groups within 0-51 D of spherical equivalence, spherical power, or cylindrical power and within 11° in cylindrical axis as determined by clinical refraction; and (2) standard error of the difference between means on the mean difference in the various refractive components between automated and conventional refraction.

Results
For the 110 eyes (110 patients) with posterior chamber IOLs which were eligible for the study valid autorefractive data could not be obtained in 10 eyes (10 patients). Various reasons included cylinder values outside the range of the instrument (five patients), inability to keep the eyes focused on the target (two patients), uncontrolled blinking, head tremor, and confusion (one patient each). Further analysis of the study data of the eyes whose cylinder values could not be estimated by the AR revealed that on clinical refraction the cylinder values in dioptres (‘plus’) were 5-0, 5-5, 6-25, 6-5, and 7-25.

The percentage agreement between autorefract and clinical refractive data with respect to the various refractive components is depicted in Table 1. More than 90% of the autorefractive values were within 0-51 D of spherical equivalence, sphere, and cylinder powers. This figure rose to nearly 100% when only reliable readings on the AR were considered. 85% of the cylindrical axis values determined by the AR were within 11° of clinical refraction, improving to 90% with reliable measurements alone. The percentage agreement between the AR and clinical data of the reliable and less reliable autorefractive data groups was compared by the χ² test. This revealed that there was a statistically significant difference between the results of the AR in two groups in spherical equivalence (p<0-05), sphere power (p<0-005), cylinder power (p<0-001), and cylinder axis (p<0-05).

In seven eyes a cylinder value was present in one of the two methods of refraction (that is, either on the AR or during clinical refraction) but not in the other. Autorefraction indicated a cylinder value in six of these eyes (three in the reliable group and three in the less reliable group) where none was found on clinical testing. A single eye needed cylindrical correction during subjective verification, but this was not displayed by the AR.

The mean differences between autorefract and clinical refraction in spherical equivalence, sphere power, cylinder component, and cylinder axis are shown in Table 2. Spherical equivalence and sphere component were both more myopic or less hypermetropic on the AR in comparison with conventional refraction, unlike the cylinder power, which was more hypermetropic and less myopic. The mean difference in cylinder axis was 4-7° (SD 6-1°).

Autorefractive data were categorised into reliable and less reliable values. The differences between mean reliable AR values and clinical refraction data were computed and compared with values derived in a similar fashion for less
reliable data. Tested by the standard error of the difference between the means to assess statistical significance, the two groups showed no difference in spherical equivalence (p > 0.09), sphere power (p > 0.7), or cylinder power (p > 0.6). However, the mean difference in cylinder axis was significant (p < 0.0001).

**Discussion**

Extracapsular cataract extraction followed by posterior chamber IOL implantation is the current method of choice in the visual rehabilitation of cataract patients. With preoperative assessment backwards towards more plus or less minus in comparison with clinical refractive data. The routine clinical practice in our unit is to adjust or remove corneal sutures after eight weeks if there is a cylindrical correction greater than 2.5 D. The five eyes mentioned above had their corneal sutures removed, but subsequent AR values have not been included in this study.

Six of the study eyes which had a cylinder component on the AR did not need it on subjective verification. Ghose et al. in their study of refractive errors in normal subjects, have pointed out that cylinder values obtained from the AR were often clinically insignificant.

The clinical impression gained during this evaluation was that autorefraction was both quick and easy to perform. Although this procedure was not timed and compared with conventional refraction, a saving in the clinician's time of four minutes per eye has been reported in a clinic setting.

In conclusion, it is suggested that an AR with a special facility for refracting pseudophakic eyes has a useful role to play in the routine evaluation of pseudophakias, particularly if these values are treated as preliminary refraction data requiring subjective verification.

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