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ORIGINAL RESEARCH

# A comparison of manifest refractions, cycloplegic refractions and retinoscopy on the RMA-3000 autorefractometer in children aged 3 to 15 years

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**Purpose:** The study was conducted to compare the accuracy of readings of the RMA-3000 autorefractometer (Topcon, Tokyo, Japan) with traditional retinoscopy as a means of determining the approximate subjective refraction in children after cycloplegia.

**Methods:** 142 children aged 3 to 15 years were included. All children had their refractive status measured with the RMA-3000 autorefractometer (noncycloplegic autorefraction [AR]). Subsequently all children underwent cycloplegia and the refractive status was estimated again with the autorefractometer (cycloplegic autorefraction [ARC]) and traditional retinoscopy (RC) by examiners who were unaware of the results from the other techniques.

**Results:** From 69 right eyes with negative sphere we observed that the sphere power was significantly higher (more than 0.5 diopters) in AR than in ARC ($P = 0.0001$) and RC ($P = 0.0001$). From the 73 normal and hyperopic right eyes we observed that the sphere power was significantly lower (more than 0.5 diopters) in AR than in ARC ($P = 0.0001$) and RC ($P = 0.0001$).

**Conclusions:** The use of the autorefractometer in children (in whom accommodation is more active than older patients) without cycloplegia may underestimate the actual hyperopia and overestimate the actual myopia. Manual retinoscopy is still the most accurate technique to estimate refractive status in children.

**Keywords:** refractometer, cycloplegia, retinoscopy, myopia, hyperopia, astigmatism

## Introduction

Ten percent of children aged 3 to 15 years old screen positive for refractive anomalies (myopia, hyperopia and astigmatism) in the United States.[1]

Detection and correction of refractive errors in infants and children is very important for two reasons: to prevent irreversible vision loss secondary to suppression of a blurred or unfocused retinal image (amblyopia), and to eliminate any visual impairment detrimental to the child's normal functioning in daily life.[1]

However, even for an experienced retinoscopist, assessment of refractive error in the pediatric population can be challenging.[1,2]

Automatic refractors have become more important in recent years because of the busy clinical schedule of ophthalmologists and increasing faith of patients in sophisticated mechanical devices.[2] Many such refractometers, subjective and objective, are now available, with steadily improving designs and greater claims to accuracy.

The present study was undertaken to compare the accuracy of the RMA-3000 autorefractometer (Topcon, Tokyo, Japan) with traditional retinoscopy as a means of determining the approximate subjective refraction in children after cycloplegia.

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## Materials and methods

The RMA-3000 autorefractometer detects light reflected from the patient's fundus to which infrared rays are directed. A built-in microcomputer deduces the objective refraction in terms of sphere, cylinder, and axis, and then automatically displays this information corrected for a 12 mm vertex distance. It completes its objective measurement in 1 to 5 seconds, with a final measurement in only 0 to 5 further seconds. The time taken for automatic fogging is 0.5 to 1 seconds with the patients seeing the fixation target, while the patient's accommodation is purportedly thoroughly relaxed by the in-built automatic fogging system. The machine can measure a sphere of up to ±20 diopters and a cylinder of ±6 diopters. A total of 284 eyes in 142 patients were tested in a comparative analysis. Analysis was performed using both the right eye and left eye. Both eyes yielded very similar results and only the results of the right eye are presented. Spherical equivalent (sphere power + [0.5 × cylinder power] measured in diopters [D]) was calculated from the refraction measurements. All subjects in this study were those who randomly and consecutively attended the outpatient department of our hospital (General Children's Hospital, Penteli, Athens, Greece) between May and August, 2003. Their ages ranged from 3 to 15 years.

Determination of the refractive error in all the eyes was done clinically as well as on the autorefractometer using a standardized protocol, but never by the same examiner. Three consecutive autorefractor measurements were performed and the average value was used for analysis. All patients underwent noncycloplegic (AR) and cycloplegic autorefaction (ARC) followed by retinoscopy (RC). The cycloplegia was achieved using cyclopentolate 1% twice (10-minute interval) and retinoscopy was performed 20 minutes after the last use of cyclopentolate 1%.

The mean age of the patients examined was 8.61 years (±0.25). Fifty-nine patients were male (41.5%) and 83 were female (58.5%). Mean weight and height of the study group were 32.93 (±1.1) kg and 128 (±2.13) cm, respectively; mean birth weight and height were 3.1 (±0.3) kg and 45.24 (±0.26) cm. Forty-nine of the patients (34.5%) in the study group had a medical history of nonophthalmologic diseases, while 68 patients (47.9%) had had previous ophthalmologic problems. Family history (first- and second-degree relatives) of refractive anomalies was positive in 73 (51.4%) of the children. The main reasons that these patients attended the Ophthalmology Department are shown in Table 1. Patient demographics are shown in Table 2. The study had the approval of our Institutional Ethics Review Board.

**Table 1** Reasons for patients attending the Ophthalmology Department

| Reason for visiting the doctor | Number (%) N = 142 |
|---|---|
| Headache | 25 (17.5%) |
| Photophobia | 3 (2.1%) |
| Foggy sight | 4 (2.8%) |
| Dizziness | 6 (4.2%) |
| Other symptoms | 11 (7.7%) |
| More than one symptom | 27 (19%) |
| Routine check | 66 (46.5%) |

All quantitive results are presented as mean ± SD. To assess changes in the measured variables before and after cycloplegia we used the repeated measures ANOVA test.

## Results

Sixty-nine right eyes had negative spherical equivalent (refractions were in negative cylinder form, sphere was negative in all these patients). The sphere power in the AR group was significantly higher than in the ARC group (–2.35 ± 2.50 D vs –1.60 ± 2.60 D, $P = 0.0001$).

Also sphere in the AR group was significantly higher than in the RC group (–2.35 ± 2.50 D vs –1.65 ± 2.60 D, $P = 0.0001$).

The negative sphere was statistically significantly different between the ARC and RC groups (–1.60 ± 2.60 D vs –1.65 ± 2.60 D, $P = 0.01$), but the difference was clinically insignificant (<0.2 D).

Seventy-three right eyes had positive spherical equivalent (refractions were in positive cylinder form, sphere was positive in all these patients). The sphere power in the AR group was significantly lower than in the ARC group (1.70 ± 1.80 D vs 2.45 ± 2.00 D, $P = 0.0001$).

**Table 2** Patients' demographics

| Features | Number (%) N = 7 |
|---|---|
| Age (years) | |
| Mean (range) | 8.61 (3–15) |
| Race | |
| Caucasian | 142 (100) |
| Sex | |
| Male | 49 (41.5) |
| Female | 83 (58.5) |
| Mean weight (kg) | 32.93 (SE ± 1.1) |
| Mean birth weight (kg) | 3.1 (SE ± 0.3) |
| Mean height (cm) | 128 (SE ± 2.13) |
| Mean birth height (cm) | 45.24 (SE ± 0.26) |

Also sphere in the AR group was significantly lower than in the RC group (1.70 ± 1.80D vs 2.30 ± 2.10 D, $P = 0.0001$).

The positive sphere was statistically significantly different between the ARC and RC groups (2.45 ± 2.00 D vs 2.30 ± 2.10 D, $P = 0.014$), but the difference was clinically insignificant.

## Discussion

Our observations in this younger age group amply bear out our earlier suspicion that the inbuilt automatic fogging system of the RMA-3000 fails to neutralize adequately the patient's accommodative efforts during manifest refraction.[3,4]

This problem declined with increasing age over 40 years and hardly existed in aphakia, mixed astigmatism, and higher refractive errors – all conditions in which the patient did not wish to or could not accommodate significantly.[3,4]

Our autorefractive results under manifest and cycloplegic conditions show that the difference is considerably higher than the known differences reported earlier by means of conventional techniques.[4,5] The same stands for the difference between the autorefractive results under manifest conditions and the results under manual retinoscopy, which is the clinical standard.[4,5]

There was a close agreement between results using the autorefractor under cycloplegic conditions and manual retinoscopy. Although the difference between the mean sphere obtained by the two methods was significant statistically, it was clinically insignificant.

In our study the use of the autorefractometer without cycloplegia in children underestimated the true hyperopia and overestimated the true myopia.

We strongly suggest that automatic refractors like the RMA-3000 should be used with great caution when determining manifest refractions, especially in younger patients in whom accommodation is more active than in older patients, because significant instrument myopia may be induced by the device or the real hyperopia may be unrevealed.[3–5] A cycloplegic refraction in these eyes would afford acceptably accurate baseline refractive data as a guideline for clinical prescription. If there are any doubts about the refractive status of the patient, manual retinoscopy can provide all the information needed.

## Disclosures

The authors disclose no conflicts of interest.

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