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A comparison of subjective refraction and automated refraction using the Epic 2100 vision diagnostic system

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Abstract
A retrospective study was performed on 124 subjects to compare the results of different methods of refraction, namely automated refraction with the Epic 2100® diagnostic system and subjective refraction performed by either of two clinicians. After analyzing the data it was found that 90.7% of the autorefractor measurements of the spherical power were within +/- 0.25D, 93.5% within +/- 0.50D, and 97.9% within +/- 0.75D of the spherical component of the prescription found by subjective refraction. The results also showed that the cylinder components were similar between the two methods in that 95.1% were within +/- 0.25D and 97.5% within +/- 0.50D of each other. Results also showed that approximately 90% of all axis measurements were within +/- 5 degrees and 96% within +/- 20 degrees. It was concluded from these findings that the spherical and cylinder powers and axis results were not statistically different when comparing subjective and automated refractions. It was determined that the cylinder axis results showed a poorer repeatability for low cylinder power than for higher cylinder powers. Bias may have been present in this study since the clinicians were not blind to the patient’s previous prescription and clinicians may refine prescription end points differently influenced by their practice experiences.

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A COMPARISON OF SUBJECTIVE REFRACTION AND AUTOMATED REFRACTION USING THE EPIC 2100® VISION DIAGNOSTIC SYSTEM

By
RITA KAILA & HERNAKE TAKHAR

A thesis submitted to the faculty of the College of Optometry Pacific University Forest Grove, Oregon for the degree of Doctor of Optometry May 2007

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Lee Ann Remington, O.D., M.S.
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**BIOGRAPHY PAGE**

Rita Kaila received her Bachelor's of Science degree in Health Science with a minor in Chemistry from California State University, Fresno. Rita was a member of Amigo's for 2yrs and hopes to return to California to practice Optometry.

Hernake Takhar received his Bachelor's of Science degree in Biology from California State University, Bakersfield. Hernake hopes to return to California to one day open a private practice with a full service ophthalmic lab.

**ACKNOWLEDGEMENTS**

We would like to send out a great thank you to the staff and optometrists at Eye-Q Vision Care Center for taking time out of their busy days to pull charts, make copies, and send them to us. We'd also like to express gratitude to Dr. Jeff Rabin for helping us start and directing us with this research project and to Dr. Peter Bergenske for helping us figure out how to analyze our data. Lastly we would like to thank Dr. Lee Ann Remington with her advice and help in writing the thesis itself.
ABSTRACT
A retrospective study was performed on 124 subjects to compare the results of different methods of refraction, namely automated refraction with the Epic 2100® diagnostic system and subjective refraction performed by either of two clinicians. After analyzing the data it was found that 90.7% of the autorefractor measurements of the spherical power were within +/- 0.25D, 93.5% within +/- 0.50D, and 97.9% within +/- 0.75D of the spherical component of the prescription found by subjective refraction. The results also showed that the cylinder components were similar between the two methods in that 95.1% were within +/- 0.25D and 97.5% within +/- 0.50D of each other. Results also showed that approximately 90% of all axis measurements were within +/- 5 degrees and 96% within +/- 20 degrees. It was concluded from these findings that the spherical and cylinder powers and axis results were not statistically different when comparing subjective and automated refactorions. It was determined that the cylinder axis results showed a poorer repeatability for low cylinder power than for higher cylinder powers. Bias may have been present in this study since the clinicians were not blind to the patient’s previous prescription and clinicians may refine prescription end points differently influenced by their practice experiences.

BACKGROUND
In the past optometry has been primarily thought of by the public as the provider of spectacles and contact lenses. The majority of the population saw an optometrist for vision care, yet did not routinely visit an optometrist for ocular pains or infections. Optometry has evolved to become the primary eye health care profession and with this evolution has come an increase in the use of technology within most practices. For example, new refractive technologies like computer assisted refracting systems (e.g., Marco Vision Diagnostic System) are viewed by some “as the next horizon in refractive care.” This technology enables doctors to delegate the data-gathering portion of the refraction and concentrate on the decision making and obtain the same results as if they had gathered all the data themselves. This allows the doctors to be more efficient and consistent and to have additional time for health assessment without adding to exam length.

The methods of measuring refractive error and the accuracy of those measurements are important considerations in patient management decisions and in the interpretation of refractive error. Many studies have evaluated the performance of autorefractors and examined the accuracy and repeatability of the measurements obtained by such instruments. The findings indicate that autorefractors provide a reasonable level of repeatability in the determination of refractive error. Despite the numerous autorefractor evaluations undertaken previously, few have compared subjective refraction with automated refraction using a computerized refraction system like the Marco Vision Diagnostic System. In this retrospective study, the results of refractive findings obtained with the Epic 2100® diagnostic system are compared with subjective refraction performed by either of two clinicians.
The Marco Vision Diagnostic System (EPIC-2100®) combines all of Marco's refracting equipment such as electronic lensometer, autorefractor, phoropter, and specialized electronic chart box in one compact unit. The EPIC-2100® has the capability of allowing the clinician to make an immediate comparison between the patient's current refractive error, prior spectacle prescription, and the new prescription. The ARK-760A, which is manufactured by Nidek and distributed by Marco has auto-acquire/auto-tracking capabilities which keeps the patient in alignment and automatically starts taking readings. It can be connected to Marco's EPIC refraction system, allowing the import of data to an electronic phoropter.

Once the patient's clinical data is entered into the the EPIC 2100® (TRS) system the person conducting the test performs auto refraction (ARK) and automatic lens analysis (LM). The data from the ARK and LM are transmitted to the TRS automated system. The result is subjectively refined to the end point of the exam. The refractive data from the ARK/LM/TRS are easily displayed for a quick comparison between the patient's prior prescription and the new subjective information. Many options are available to the clinician to structure the test to their preference. Some of the options include: the measurement of corneal diameter, pupil size, inter pupillary distance, vertex distance, and near working distance, as well as objective measurements from the ARK, the bichrome test, prism measurement, and the cross cylinder test for cylinder and axis refinement. In addition, it also offers easy access to different types of charts useful for vision testing.

METHODS
This was a retrospective study and consisted of a random sample of 124 non-cyclopleged subjects, all of whom had their vision exams at Eye-Q Vision Care Center between July 2001 and October 2005. The sample included the refractive errors from both eyes of 38 men and 86 women (n = 248) ranging from 17 to 40 years of age and excluded all subjects that had been diagnosed with any ocular pathology or systemic disease at the time of the exam. The refractive error of the sample was taken from both automated and subjective refraction methods and ranged from a spherical power of -10.75 to +1.50D and a maximum cylinder of +6.75.

Subjects were refracted with the Marco Epic refraction system by one technician and then immediately refracted by either of two experienced optometrists. During the examination the optometrists compared the Epic printout with their manual refraction results. At the end of the examination the final prescription was determined by the optometrist.

The data was collected by reviewing the charts of the randomly selected group. The data was initially organized into six categories of refractive error which included: plano to +3.00D, +3.00 to +6.00D, >+6.00D, plano to -3.00D, -3.00D to -6.00D, and >-6D. No subjects had >+1.50D of refractive error therefore, the majority of data sample consisted of myopes and the number of categories was reduced to four. Statistical analysis
included determination of the mean difference, standard deviation, and 95% confidence intervals and the results are listed in Table 1.

RESULTS
A comparison between the findings of the EPIC automated refraction and the subjective refraction for sphere, cylinder, and axis are given in figures 1-3 shown by plotting the difference between the two measurements as a function of the mean of the two measurements. Figure 1 shows the difference in the spherical power component between automated and subjective refraction compared with the mean of the spherical power. Figure 2 shows the difference in the cylinder power component between automated and subjective refraction compared with the mean of the cylinder power. Figure 3 shows the difference in the cylinder axis component between automated and subjective refraction compared with the mean of the cylinder axis. Repeatability was determined by the 95% limits of agreement, which represent the central 95% distribution of the differences. The 95% limits of agreement represent a 95% probability that the difference between a measurement of refractive error determined by automated and subjective methods will be within the calculated range.

The prescription constituent differences between automated refraction and subjective refraction are shown in Table 1. Each component of the prescription was separated into the four categories of refractive error (category 1: greater than -6.00D, category 2: between -3.00D and -6.00D, category 3: between plano sphere and -3.00D, and category 4: between plano sphere and +3.00D). The 95% limits of agreement (LoA) for the EPIC automated refraction and the subjective refraction mean differences are also shown in Table 1 and listed as sphere, cylinder, and axis for each of the four categories. The results indicated that 90.7% of the autorefractor measures were within +/- 0.25D, 93.5% within +/- 0.50D, and 97.9% within +/- 0.75D of the spherical component of the prescription found by subjective refraction. With respect to the cylinder power the results indicated that 95.1% of the autorefractor measures were within +/- 0.25D and 97.5% were within +/- 0.50D of the subjective refraction cylinder power findings. Approximately 90% of the axis measurements taken by the autorefractor were within +/-5 degrees and 96% were within +/- 20 degrees of the measurements determined by subjective refraction. These results are comparable to those in a study done by Zadnik et al. in which manifest or non-cycloplegic autorefractor and subjective measures of refraction gave similar limits of agreement.

CONCLUSION
The findings demonstrate that spherical results, regardless of power, found by automated refraction were slightly more positive but not statistically different from the subjective refraction measures. It was also found that the cylinder power results found by the autorefractor were slightly more negative and not statistically different from those found by subjective means. In a study done by Davies et al., evaluating the Shin-Nippon NVision-K 5001 autorefractor, it was found that approximately 50% of the autorefractor measures were within +/- 0.25D and 85% within +/- 0.50D of the spherical component of
the prescription found by subjective refraction. The evaluation of the EPIC-2100®
refractive system in this present study found that the spherical components of the
subjective and autorefraction measurements had a much higher percentage within +/-
0.25D and +/- 0.50 as is mentioned above. This trend continued with the results for
cylinder power and axis differences.

Although the cylinder axis results showed no statistical difference, the results were more
variable because the repeatability was poorer for low cylinder powers than for high
cylinder powers. It was determined that almost all of the outliers that showed a
significant difference in cylinder axis between objective and subjective measures were
those of low cylinder powers. A separate study done by Bullimore et al, determined that
the 95% limits of agreement for axis decreased from +/- 27.8° to +/- 10.8° when subjects
with ≤ 0.50D of cylinder power were excluded from their sample.8

Although the attempt was made to eliminate bias from this study, it is possible that
certain biases or sources of error did exist. One possible error can be attributed to
fluctuations of accommodation that can occur in a patient seated in an autorefractor or
similar instrument. This has the potential to cause a disparity of up to .50D between
measures.4 Instrument myopia may also cause accommodative fluctuations. Another
possible bias is that the refracting clinician was not masked to the subject’s previous
findings and the habitual spectacle correction. Another likely bias could be the slight
variations that can exist in the end point of prescriptions obtained by different clinicians,
this is often called the “art” of optometry and is influenced by a number of factors
including education and clinical experience. It should also be noted that the use of only
two clinicians may limit generalizing our findings.8

The validity of autorefractors is traditionally assessed by comparing their results to that
of subjective refraction. This is because they are principally designed to assist the
optometrist in reaching the endpoint of subjective refraction as quickly and as accurately
as possible, in a role similar to that of retinoscopy.9 Although this study has shown that
an objective method of measuring refractive error can determine the patient’s optical
error requirements with great accuracy, it is also of vital importance that a subjective
refraction be done because it can provide the practitioner with qualitative information that
would otherwise be missed and could result in a decrease of patient comfort or
compliance. In a study by Strang et al 4, it was determined that 38.3% of subjects
indicated that they would complain about the lenses prescribed by the autorefractor,
whereas 10.6% of subjects said they would complain about the subjective result.

In summary it was determined that even though bias existed within the study, no
statistical difference existed between autorefractor and subjective refraction findings. It
could be proposed that a more preferable indicator for evaluation of objective versus
subjective measures could be to use the patient’s preference as the key criterion.
REFERENCES


2. Catania L. "Optometry's growth over 30 years has not addressed refraction." Publication obtained from Marco company representative.


5. Mitchell R., "Leading practice streamlines operations with state of the art technology." Publication obtained from Marco company representative.


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Table 1. Statistical Evaluation of the difference in refractive components of automated refraction and subjective refraction. (* CI= confidence interval)
Figure 1. The difference in the spherical power component between the automated and subjective refraction compared with the mean of the spherical power.
Figure 2. The difference in the cylinder power component between the automated and subjective refraction compared with the mean of the cylinder power.
Figure 3. The difference in the cylinder axis component between the automated and subjective refraction compared with the mean of the cylinder axis