Comparison of Simulated K's as Measured by the Humphrey Computerized Videokeratographer To Standard Keratometry

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ABSTRACT

The accuracy of the simulated K-readings as determined by computerized videokeratographers (CVK's) is critical if using the CVK to calculate residual astigmatism in rigid contact lens fitting or in surgery calculations (IOL or refractive) [1,5]. *Simulated K's should correlate well with standard keratometry measurements if the CVK is to be useful for these applications. Several studies have been conducted regarding this correlation using different CVK's. Results have been mixed. A 1994 study demonstrated that simulated K's often differ substantially with keratometry. In the case of the EyeSys, toricity is underestimated by as much as 25%* [6,12]. *This study utilizes the methods from that study to assess the accuracy of the new Humphrey Systems ATLAS with MasterVue Software. Three front-toric rigid contact lens buttons were measured with an American Optical radiuscope, a Topcon OM-4 keratometer, and the Humphrey CVK. The results suggest that greater accuracy is possible with this CVK.*

INTRODUCTION

The accuracy and repeatability of simulated K's from different computerized videokeratographers (CVK's) has been widely debated in the literature[1-16]. Specifically, studies conducted comparing various CVK generated simulated K's to standard keratometry have shown mixed results [1,2,4,7,8,9,11,14,15]. To date, little discussion has been published concerning the newest Humphrey CVK, the ATLAS with MasterVue Software, particularly, in regard to this correlation. This CVK (as do most) provides corneal curvature values (simulated K's) reported to be equivalent to those measured with a standard keratometer. Since these values are essential when using a CVK to assist in the proper fitting of RGP's, in IOL calculations, or in calculations for refractive surgery, toricity measurements of known toric surfaces (contact lens buttons with toricities of 1.11, 2.89, and 3.74 D as measured by the keratometer) were taken with the Humphrey CVK and compared to standard keratometry.

METHODS [12]

Art Optical Laboratories (Grand Rapids, MI) generated three front toric surface buttons with spherical back surfaces from PMMA material. Button #1 had a surface power of plano/-2.00 D and a center thickness of .17mm. Button #2 had a surface power of plano/-4.00 D and a center thickness of .15mm. Button #3 had a surface power of plano/-6.00D and a center thickness of .13mm.

These buttons were each measured 10 times on an American Optical radiuscope by mounting them prior to each reading with Boston RGP Conditioning Solution on the pedestal designed for front-surface measurements.

Each button was then measured 15 times on a Topcon OM-4 keratometer. The buttons were mounted on a steel ball bearing held in front of the instrument by a Lensco-meter (a device used to calibrate the keratometer and hold contact lenses in front of the keratometer to measure base curves; Lensco Precision Instrument Co., Branford, CT). The ball bearing, with a 7.94 mm radius, was held in place by a magnet that allowed easy rotation and positioning of the buttons. The buttons were mounted on the ball bearing with a small drop of Boston RGP conditioning solution that held it in position by surface tension and eliminated reflections from the back surface of the button. To eliminate reflections from the steel ball bearing, the back surface of each button was painted with dark blue oil-based model paint. After each reading, the button

CVK measurements were performed on the Humphrey Systems ATLAS with MasterVue Software (Model 991, Version A8). For simulated K measurements, the buttons were mounted with Boston RGP Conditioning Solution onto the 8.00mm calibration ball provided with the Humphrey system. A Kim wipe was placed between the ball and the buttons to control lens movement. This better insured proper alignment and also helped with decreasing outside reflections. Great care was taken for proper alignment and focus to be achieved. Only readings judged by the system as "high confidence" were accepted. In addition, we excluded simulated K readings associated with topography maps that didn't exhibit a classic "bow-tie" pattern. Each button was measured 15 times: 5 readings at axis 180, 5 at axis 90, and 5 at axis 135. The button was remounted between axis changes (every 5 readings).

RESULTS

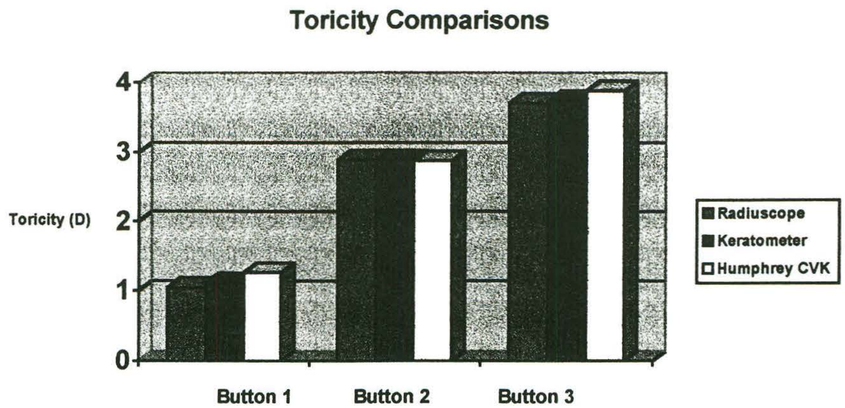
Table 1 shows the mean millimeters of radii for each meridian, their dioptric equivalents, the mean toricity measured on each button by each instrument, and the standard deviation of each toricity measurement.

Table 1

	Button 1		Button 2		Button 3	
Instrument	Flat	Steep	Flat	Steep	Flat	Steep
Radiuscope						
Mean (mm)	8.29	8.08	8.65	8.06	8.87	8.09
Diopter	40.72	41.76	39.01	41.90	38.03	41.73
Toricity (D)		1.04		2.89		3.70
SD (D)		0.07		0.19		0.19
Keratometer						
Mean (mm)	8.30	8.08	8.70	8.10	8.91	8.11
Diopter	40.65	41.76	38.79	41.68	37.88	41.62
Toricity (D)		1.11		2.89		3.74
SD (D)		0.18		0.15		0.21
Humphrey CVK						
Mean (mm)	8.30	8.05	8.64	8.04	8.90	8.07
Diopter	40.65	41.90	39.08	41.96	37.94	41.82
Toricity (D)		1.26		2.88		3.88
SD (D)		0.09		0.17		0.22

Figure 1 displays the mean toricity readings each instrument measured on each button. The difference between toricity measured by the CVK and that measured by the keratometer is less than a quarter diopter. Although the difference is greater between the radiuscope and the CVK, it remains under a quarter diopter. Measurement correlation holds true for low, medium, and highly toric surfaces. This CVK tends to measure more toricity than the radiuscope or keratometer; however, the differences are not clinically significant.

Figure 1



DISCUSSION

In regard to the many CVK's available, as stated previously, results have been mixed. A 1998 study using EyeSys, TechnoMed C-Scan, and PAR Corneal Topography Systems found the instruments to correlate well with each other and with manual keratometry [11]. However, this same study also concluded that different systems couldn't be interchanged in clinical studies. Another study comparing K's from the Zeiss keratometer with simulated K's from the TMS-1 on normal and post-keratoplasty corneas found manual keratometry readings to be more reproducible and not interchangeable with topographic data on highly astigmatic corneas [8]. Finally, a 1998 study using the EyeSys (Model II) found simulated keratometry values were not interchangeable with manual K's [2].

Simulated K's as measured by CVK's are very dependent upon proper alignment and good focus for accurate readings. We found that the slightest misalignment or focusing error would impact readings dramatically. Also, it was very difficult to control outside reflections, as the CVK is very sensitive in picking up extraneous reflections. It was for these reasons that a KimWipe was placed between the lens and the calibration ball during CVK measurements. This controlled lens movement and outside reflections best. Therefore, making consistent measurements possible.

This study confirms the 1994 study; there is no significant difference between toricity measurements from the radiuscope and the keratometer [12]. In a 1998 study measuring the accuracy of 4 different CVK's using calibration spheres, the Humphrey ATLAS was found to be the most accurate [7]. In our study, the Humphrey ATLAS with MasterVue Software provided simulated K's that correlate well with standard keratometry when using toric surfaces. Although the sample size was not large enough to provide statistical proof of correlation, it is evident that no clinical difference exists between keratometry measurements and the simulated k's produced by this CVK. Mean toricity measurements fell within a quarter diopter for all buttons for all three modalities. This certainly falls within the range of human error expected for maintaining proper focus and alignment during each measurement. In the future. a similar study should be performed on a large patient population to determine if this correlation stands when measuring the various curvatures of the human cornea.

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