# A Comparison of Manual Keratometry and Simulated Keratometry When Determining Central K-Readings


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## Introduction

When fitting a contact lens, information about the corneal shape is essential. Traditionally, corneal front surface radii obtained by manual keratometry have been used to find a matching contact lens back surface. [1]

Especially when fitting a rigid lens, minor deviations in surface radii can have substantial impact on the fitting outcome. Thus, any device used for obtaining corneal shape information must provide clinically acceptable measurements.

Modern corneal topographers typically analyze the apical radius $R_0$ and a variety of other shape descriptors. To accommodate contact lens fitting algorithms, they can simulate data obtained by keratometry, called Sim-K.

Several scientific studies analyzed differences in apical radius and corneal shape measurements of various topographers, and found the Medmont E-300 to be an accurate and precise instrument. [2–3]

The purpose of our study was to compare measurements of central corneal curvature in healthy human corneas, obtained with a modern corneal topographer and a standard manual keratometer.

## Methods

We measured central corneal radii in right eyes of 41 subjects (28 females, 13 males), age range 23 to 45 (Mean 28, SD 4), refractive error range sph -14.75 to +3.25 (Mean -2.55, SD 3.16), cyl -2.50 to 0.00 (Mean -0.52, SD 0.67) with a manual Marco KI keratometer and a Medmont E-300 topographer (Fig. 1).

Exclusion criteria were: active eye disease, irregular astigmatism, and s/p refractive surgery.

We measured each cornea three times with each instrument and used average values. Corneal radii were converted into power vectors M, $J_0$, and $J_{45}$, using Fourier analysis, as proposed by Thibos et al. [4]

For statistical analysis we performed Wilcoxon matched-pairs signed rank tests and Bland-Altman analysis, and computed Pearson's correlation coefficient r, using Graphpad 6 statistical software.

A statistical significant difference was confirmed when P values < 0.05. Following tolerances outlined by ANSI Z80.20, clinical relevance was considered for the following deviations: M > ±0.25 D, $J_0$ and $J_{45}$ > ±0.12 D.

## Results

For the M and $J_0$ vector data we found statistically significant differences with P < 0.0001 and P = 0.02, respectively.

For the $J_{45}$ vector values we found no statistically significant difference, with P = 0.87.

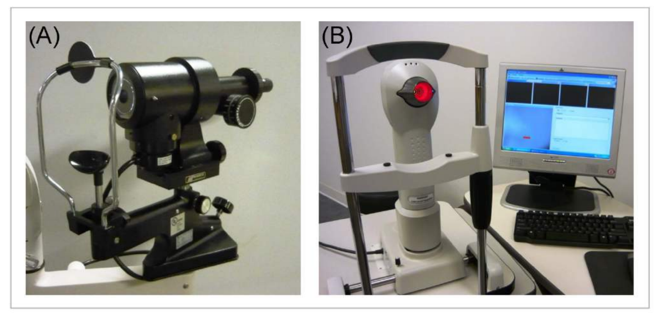


Fig. 1: (A) Marco KI keratometer, (B) Medmont E-300

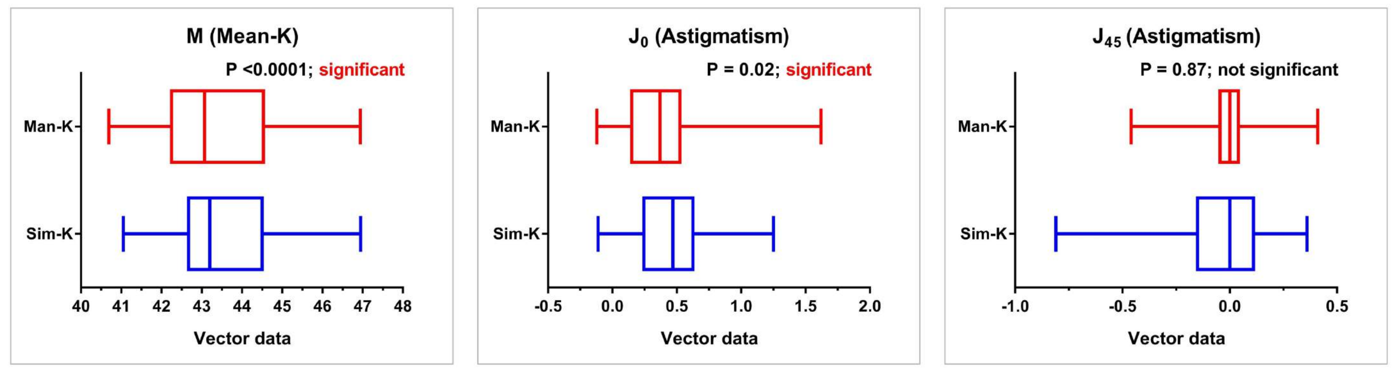


Fig. 2: Box-and-Whisker plots for power vector data M, $J_0$, and $J_{45}$. All values are expressed in diopters. Each box shows the median (vertical line), 25th and 75th percentiles (outer walls of the box), minimum and maximum values (whiskers). The P value, obtained by Wilcoxon matched-pairs signed rank test, as well as the significance level are displayed in each graph.

Using the median of differences, and following the recommendation for tolerances given by ANSI Z80.20, we found no clinically relevant differences for the $J_0$ and $J_{45}$ astigmatic vector data (-0.08 D and -0.01 D, respectively).

However, the M vector data (Mean-K) showed median differences of -0.35 D. This exceeds the limits of clinically acceptable tolerances, and means that the keratometer measured generally 0.35 D less than the corneal topographer.

When computing the variances $r^2$ for the vector data, we found 0.94 for M, 0.71 for $J_0$, and 0.42 for $J_{45}$. Since only the M data were outside the ANSI tolerances, and the correlation was high, data might be converted between instruments.

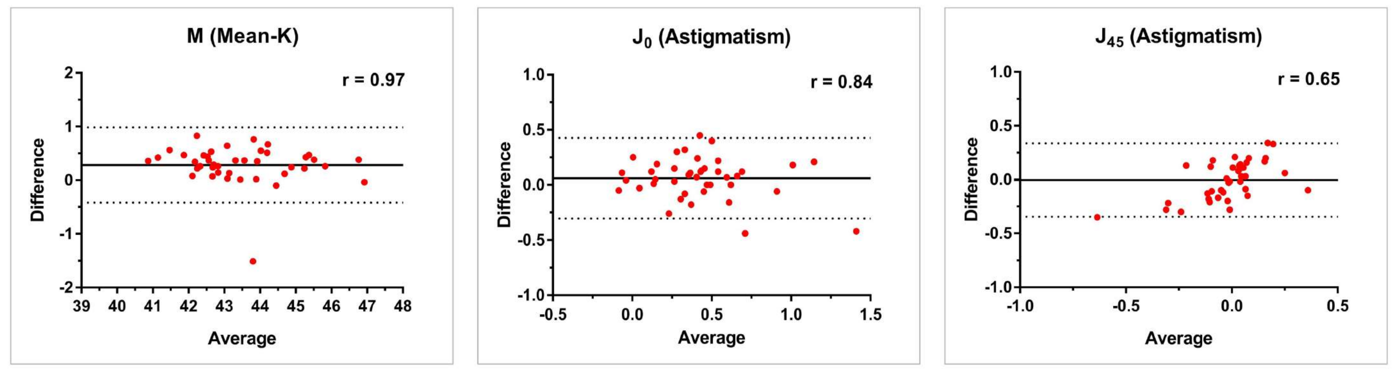


Fig. 3: Bland-Altman plots for power vector data M, $J_0$, and $J_{45}$. All values are expressed in diopters. The difference was obtained by using the topographer as the reference instrument, and calculating: (Sim-K minus Man-K). The black horizontal line is the bias, and the two dotted lines mark the 95% limits of agreement. Pearson's correlation coefficient r is displayed in each graph.

## Conclusions

**Statistical significance and Clinical relevance**

When measuring central corneal curvature data in healthy human corneas, the Medmont E-300 topographer and the Marco KI manual keratometer produced statistically significantly different results for the power vectors M and $J_0$.

The median difference for the Mean-K power vector M was -0.35 D, with the keratometer measuring flatter radii than the topographer. This difference is outside the ANSI Z80.20 tolerance, and therefore reaches clinical relevance.

The median differences for the astigmatic power vectors $J_0$ (-0.08 D), and $J_{45}$ (-0.01 D) were very small and did not reach a level of clinical significance.

Especially for the Mean-K vector M, the outcomes of both instruments were strongly correlated (r = 0.97). Therefore data obtained by both instruments are clinically useful, but should not be used interchangeably.

This requires consideration in optometric patient care and recalibration when comparing central corneal radius measurements from both instruments.

## References and Contact Information

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- None of the authors reports a conflict of interest