Determining the basic keratometric data required to calculate intraocular lens powers with the IOLMaster after refractive corneal surgery

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ABSTRACT

The number of cataract patients who have undergone previous laser treatment of the cornea, hereinafter designated as Laser Vision Correction (LVC), is constantly increasing. Modern biometric formulae, e.g. the Haigis-L formula, also allow the simple calculation of an intraocular lens for this group of patients, using only data measured with the IOLMaster before cataract surgery. The following study was conducted in order to check the reproducibility of measurements with the keratometer of the IOLMaster on patients after LVC and to compare this with the data prior to LVC.

For this purpose, 3 individual measurements were performed per eye pre-LVC and then 3 months postoperatively. The individual maximum and minimum values were compared in each case.

RESULTS:

Mean corneal power – difference between the individual maximum and minimum values

0.09 ± 0.09 D [0.00 … 0.52] pre-LVC and

0.10 ± 0.08 D [0.07 … 0.39] post-LVC,

mean difference between the maximum and minimum astigmatisms

0.21 ± 0.19 D [0.00 …. 1.35] pre-LVC and

0.23 ± 0.21 D [0.00 … 1.68] post-LVC,

mean difference between the maximum and minimum axis of a principal meridian for cylinders larger than 1 D

3.83 ± 3.07 degrees [0 … 16] pre-LVC and

4.41 ± 3.97 degrees [0 … 20] post-LVC.

The examination of the differences between the minimum and maximum spherical equivalent of the individual measurements shows that deviations within one measuring series are very low. With 92% pre-LVC and 95% post-LVC within 0.25 D, 99% (pre-LVC) and 100% (post-LVC) lower than 0.50 D and 100% lower than 1.00 D (pre- and post-LVC), the keratometer shows very high reproducibility pre- and post-LVC.

Therefore, the IOLMaster shows its good reproducibility post-LVC and hence its suitability for cataract patients after LVC for determining base data required for power calculation using the Haigis-L formula.

The IOLMaster has been used for calculating the power of intraocular lenses (IOLs) for more than ten years now and, with the Haigis-L formula, offers a convenient possibility of calculating IOL powers after refractive corneal surgery.(1)

The benefit of this method is that there is no need for additional data, e.g. preoperative values prior to Laser Vision Correction (LVC) such as in the clinical history method, for example, or from an "overrefraction" with contact lenses as in the contact lens method.

The data required to calculate an intraocular lens after LVC with the Haigis-L formula is the standard values measured prior to the planned IOL implantation: axial length, depth of the anterior chamber and corneal radii/corneal power.

This raises the question as to whether the keratometries with an IOLMaster are also sufficiently reproducible after LVC to obtain exact base data for post-LVC IOL power calculation.

METHOD:

Keratometries with the IOLMaster were performed preoperatively and 3 months postoperatively within the framework of clinical studies for Laser Vision Correction conducted at the Eye Clinic of the Helios Klinikum in Erfurt, Germany. The study was approved by the Ethics Committee of the Thuringian Regional Medical Council (‚Landesärztekammer Thüringen').

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This data was used retrospectively to answer the question asked above. The evaluation included only those eyes for which 3 individual measurements were present both preoperatively and postoperatively in each case.

The population is not a cataract population, but it is very suitable for evaluating the reproducibility of corneal power measurements before and after LVC.

Keratometric data was obtained for 96 patients (186 eyes) within the framework of the preliminary and follow-up examinations.

The mean age of the examined population was 35.96 ± 9.52 years [21.39 … 62.97], with 59% female, 41% male.

The preoperative subjective refraction was:

Sphere: -4.18 ± 1.44 D [0 …-9.00]

Cylinder: -0.69 ± 0.83 D [0 …-6.00]

Spherical equivalent (SE):

-4.52 ± 1.4 D [-1.63 …-9.00]

Fig. 1 shows the distribution of the spherical equivalent in the examined population. The specified corneal powers are the mean of the two principal meridians. They were calculated from the anterior corneal radii with a keratometer index of 1.3375.

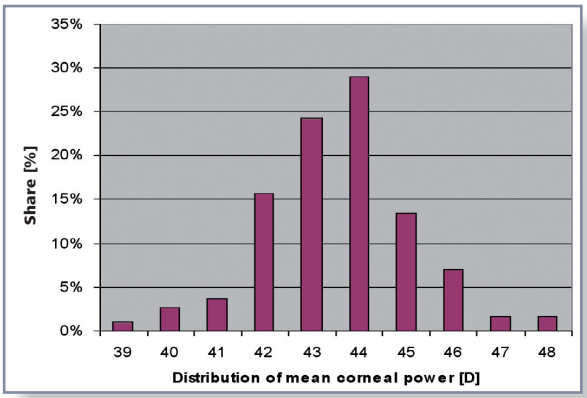

Fig. 1: Distribution of the cylinder powers in the examined population, divided into 0.25 D groups

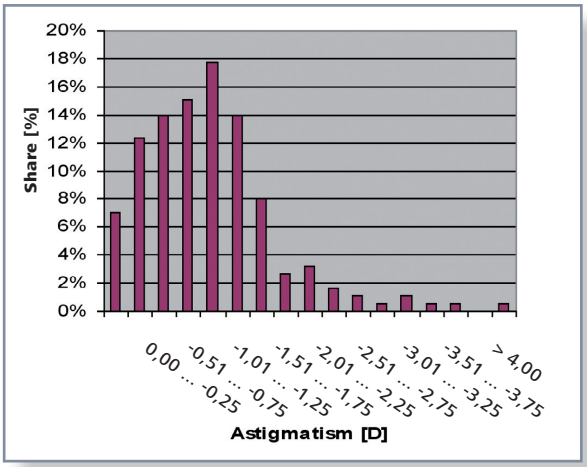

Fig. 2: Distribution of the cylinder powers in the examined population, divided into 0.25 D groups

Fig. 2 shows the share of the astigmatism powers in the population, divided into 0.25 D groups.

A patient population which is typical of refractive corneal treatment is evident.

The mean axial length of the patient population was 25.05 ± 0.88 mm [22.55 … 27.12] and the mean anterior chamber depth 3.75 ± 0.31 mm [2.19 … 4.39].

No other ophthalmic pathologies were present apart from the myopia or myopic astigmatism to be treated.

During the examinations the patients were measured, among other things, with the keratometer of the IOLMaster. Three individual measurements per eye were performed immediately after one another, the refractive power in the strongest and weakest meridian was measured and the axis was determined. The individual values were compared to obtain informa-

tion on the reproducibility per eye. For this purpose, both the minimum and the maximum values per principal meridian and the spherical equivalent (SE), the astigmatism (CYL) and its axis (Ax) were determined in each case. The difference between the maximum and minimum values per eye was used as a measure of the "quality" of one measuring series per eye.
In the examinations of the astigmatism axis, the eyes were grouped according to cylinder powers because, as is widely known, the accuracy of axial measurements is heavily dependent on the cylinder power.
In the manner described, results were obtained both for the reproducibility of the spherical equivalent and for the power and position of the cylinders.

RESULTS:

The preoperative reproducibility of the spherical equivalent (SE) of the corneal power – the mean difference between the minimum and maximum SE of the 3 individual measurements per eye – is:

0.09 ±0.09 D [0.00; 0.52]

and the postoperative value is:

0.10 ±0.08 D [0.00 … 0.39].

The distribution of the differences between the minimum and maximum SE is shown in Fig. 3. Deviations within one measuring series are very minor. With 92% pre-LVC and 95% post-LVC within 0.25 D, 99% (pre-LVC) and 100% (post-LVC) lower than 0.50 D and 100% lower than 1.00 D (pre- and post-LVC), the keratometer shows very high reproducibility.

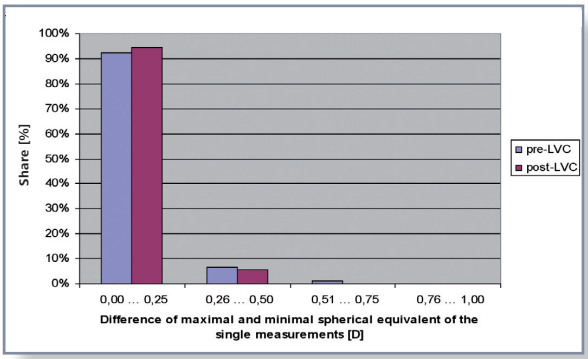

Fig. 3: Distribution of the differences of the SE, determined from the minimum and maximum SE of the 3 individual measurements, preoperatively and postoperatively (3 months post-LVC)

As LVC patients have high visual demands, they may also be candidates for a toric intraocular lens if high astigmatism remains. For this reason, the reproducibility of cylinder power and axis measurements was additionally examined.

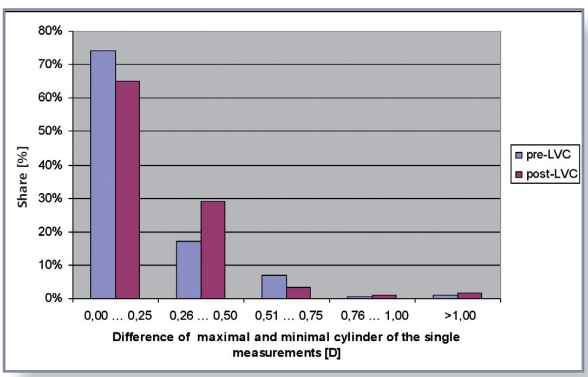

Fig. 4: Share of the differences between the maximum and minimum cylinder powers of the individual measurements as a measure of the reproducibility of cylinder power measurements

The values of the pre- and post-LVC cylinder power differences do not vary significantly. 74% (pre-LVC) or 65% (post-LVC) lay within 0.25 D, 91 or 94% within 0.50 D and 99 or 98% within 1.00 D.

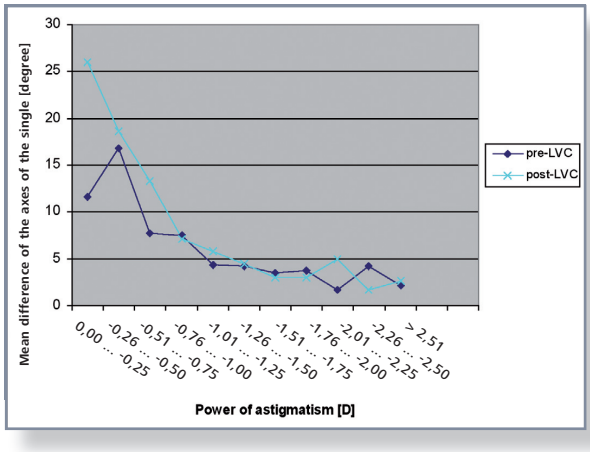

Fig. 5: Mean difference (maximum individual value versus minimum individual value) of the axes of one principal meridian.

An analysis of the axes is shown in Fig. 5.
As expected, an exact axial measurement is not possible with low cylinder powers; with values from approx. 1 D the mean axial difference is less than 5 degrees both pre- and post-LVC.

DISCUSSION:

Both pre- and post-LVC, the scatter of individual measurements with the keratometer of the IOLMaster shows comparable reproducibilities in measurements of mean corneal power and of the power and position of the astigmatism.
Mean corneal power difference of

0.09 ± 0.09 D [0.00 … 0.52] pre-LVC and
0.10 ± 0.08 D [0.07 … 0.39] post-LVC,

mean difference between the individual measurements for the power of the astigmatism of

0.21 ± 0.19 D [0.00 …. 1.35] pre-LVC and
0.23 ± 0.21 D [0.00 … 1.68] post-LVC,

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3.83 ± 3.07 degrees [0 … 16] pre-LVC and
4.41 ± 3.97 degrees [0 … 20] post-LVC.

The good comparability of the preoperative and postoperative values for all parameters obtained with keratometry shows that, for calculating the power both of spherical and of toric lenses after refractive corneal surgery, preoperative data does not necessarily have to be present.
The results correspond to those found by Vogel et al. of 0.069 D regarding variability within one measured series of one examiner and 0.088 D for variability within a group of examiners.(2)
With data of 187 cataract procedures with 32 IOL models implanted by 57 surgeons after previous refractive corneal surgery, Haigis showed that the clinical results with a correct refraction prognosis of 61.0, 84.0 and 98.4% within ±0.5, ±1.00 and ±2.00 D are of similar quality to those obtained for intraocular lens implantations without previous LVC.(2)

CONCLUSION:

The keratometer of the IOLMaster is very suitable for determining base data for the calculation of an intraocular lens after previous refractive corneal surgery, in particular for determining base data for calculating IOL powers with the Haigis-L formula.
The determined reproducibilties of the measurements lie in the range of the preoperative values. Laser Vision Correction does not therefore lead to a reduction of the keratometer's measuring accuracy.

LITERATURE:

1. Haigis W, Intraocular lens calculation after refractive surgery for myopia: Haigis-L formula, J Cataract Refract Surg 2008, 34(10):1658-63.
2. Vogel A , Dick HB , Krummenauer F. Reproducibility of optical biometry using partial coherence interferometry: intraobserver and interobserver reliability, J Cataract Refract Surg 2001, 27(12):1961-8.

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