IOL calculation after refractive surgery
(Wolfgang Haigis)

There is an increasing number of patients presenting with cataract after preceding laser vision correction (LVC). Eyes after corneal surgery still pose a challenge to IOL calculation, although the origin of most of the problems associated with these eyes are well understood meanwhile.

**Specific problems for IOL calculation after refractive surgery**

Three main sources for errors in IOL calculation after refractive surgery can be identified: First, there is a measurement problem for keratometry due to the fact that K readings are not taken at the optical center but slightly to the periphery. A radius of curvature thus measured in an eye after myopic LVC has a good chance to come out a little steeper than in the centre. Consequently, an IOL too weak is calculated. This error is relevant in formerly myopic eyes, not for prior hyperopia.

The second error is the keratometer index error. It stems from the implicit assumption in keratometer calibration that anterior and posterior corneal radii of a given eye have a fixed ratio. The validity of this assumption is essential for the conversion of measured radii in mm into Ks in diopters with the help of the keratometer index. This ratio is deliberately changed by refractive surgery thus causing meaningless K values.

The third error is known as the IOL formula error. Most theoretical IOL formulas (with the exception of the Haigis formula) use K values as predictors of the effective lens position. Eyes after refractive surgery, however, present K values which by no means represent the eye's geometry in its untouched state. The IOL position in patients after laser surgery for myopia is thus assumed to be more anterior than in reality which gives rise to an additional significant hyperopic refractive shift.

**Literature approaches**

A multitude of publications dealing with eyes after refractive surgery can be found in the literature. Formulas to come up with the correct power of the cornea as well as algorithms to derive the correct IOL power are given. Many approaches require historical patient data prior to the refractive intervention or are only valid for specific measurement instruments or specific IOL power formulas. There is no magic universal solution which can be used with all formulas and all instruments. The measurement error e.g. depends on the dimensions of the optical zone as well as on the measurement instrument used. Both change with the years, and new formulas will emerge in the future.

An essential feature of IOL calculation methods for eyes after refractive surgery is whether they require patient data prior to the refractive intervention or whether they rely only on current measurements. Obviously, these no-history methods are clinically the most important ones, since historical patient data are often very hard to get. No-history approaches are e.g. the R-factor method of Rosa et al [1], the BESSt formula of Borasio et al [2] based on the Pentacam, the no-history method of Shammas & Shammas [3], and the Haigis-L formula [4] for the IOLMaster, results of which will be presented in the following.

**Results with the Haigis-L formula**

At present we have collected results for 278 eyes (published [4] only in part) after IOL implantation following LVC, of which 222 were previously myopic and 56 hyperopic. The myopic eyes received 35 different IOL types from 64 surgeons; the hyperopic eyes were supplied with 13 different IOL types by 15 surgeons. All patients had undergone IOLMaster biometry (axial length and ACD) and keratometry. IOL calculation was performed using the Haigis-L formula which is implemented in the IOLMaster software from version 4 onwards. Most cases were calculated prospectively.

The mean arithmetical prediction errors were -0.08 ± 0.71 D for the myopic and -0.06 ± 0.77 D for the hyperopic eyes; the respective medians of the absolute prediction errors amounted to 0.37 D and 0.40 D. The percentages of correct refraction predictions within ± 2 D, ±1 D and ± 0.5 D were 98.6%, 82.9% and 59.9% for the myopic and 96.4%, 82.1% and 58.9% for the hyperopic eyes. These results compare well with normal eyes, although the error margins in predicted refraction are a little higher after refractive surgery.

Among the first publications dealing with the problems of IOL calculation after refractive surgery was Jaime Aramberri’s paper on the double-K method [5], which fixes the IOL formula error. The Haigis formula is not affected by this error as it does not use the K readings to predict the effective lens position. Fig.1 [6] shows a comparison of the Haigis-L with the double-K method applied to the popular SRK/T formula [7] in terms of correct refraction predictions. The Haigis-L formalism compares very...
favourably as can be seen. This is due to the fact that while the double k-method heals the IOL formula error of SRK/T, it does neither correct the keratometer index error nor the measurement error as the Haigis-L does.

**Internet resources**

Support for IOL calculation after refractive surgery can be found in the internet: The ASCRS website www.ascrs.org e.g. offers free usage of a variety of published calculation schemes in their online calculator. Also, the so-called Hoffer/Savini tool, which is a spreadsheet programmed with all algorithms published so far, can be downloaded from Dr. Ken Hoffer’s website www.eyelab.com at no costs.

**References**


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