Achieving Better Outcomes Using Free Online Post-LASIK IOL Calculators

The accuracy of any calculator depends on the quality of the data being input.

BY DENNIS H. GOLDSBERRY, MD, PE, FACS

Axial length and corneal power are the basic variables used in the calculation of IOL power. Modern theoretical formulas also calculate effective lens position (ELP), either through estimation based on corneal power, such as with the SRK/T, Hoffer Q, and Holladay formulas, or through direct measurement of anterior chamber depth, such as with the Haigis formula.[1-4] Accurate IOL calculations in the presence of previous refractive surgery are complicated by the fact that the relationship between the anterior and posterior corneal curvatures is significantly altered. Because keratometers and topographers measure only the anterior corneal power, they use an altered index of refraction to compensate for the presence of posterior corneal power. But after refractive surgery, these assumptions are no longer valid. These errors propagate into the calculation of ELP in theoretical lens formulas, further compounding the problem, and in many cases lead to a postoperative refractive surprise.

At last count, more than 30 methods—*fudge factors*—have been developed to compensate for sources of error that are introduced in the altered cornea.[4-20] However, little widespread testing has been done with most methods, and the vast majority has been tested only for patients with previous myopic LASIK treatments. Most, however, can also be applied to eyes after radial keratotomy, PRK, and LASIK hyperopia treatment with success. They can be divided into four categories, which are described in detail in Table 1: (1) Methods that require preoperative keratometry, better known as historical methods, (2) methods that do not require preoperative keratometry but do require a preoperative manifest refraction, (3) methods that require no knowledge of preoperative state; and (4) methods that require specialized equipment.

Intuitively it would seem that, with more data available, the results would be more accurate. However, preoperative data are obtained by review of the medical record—often the notes of a different surgeon in a different place and time long past. This may be why historical methods have underperformed in some head-to-head studies.[5,6] Additionally, there may be occasions when no old medical records exist, severely limiting the options available. In these cases, an old pair of glasses or a prescription prior to vision correction surgery may provide the only clues to the patient's preoperative state. Even in the absence of such information, IOL calculations can be done.

ADVANTAGES OF ONLINE TOOLS

Surgeons are tasked with deciding which method is best for each patient and calculating the correct IOL power. Ten years ago, this process involved pencil and paper. Seven years ago, spreadsheets began to circulate among ophthalmologists to try to simplify the process, but it was still a burdensome and time-consuming task to reach the final answer. In the past 5 years, two Web-based calculators have appeared: the OcularMD Post-LASIK IOL Calculator (iol.OcularMD.com; Figure 1) and the ASCRS IOL Calculator (iol.ascrs.org).

TABLE 1. POSTREFRACTIVE SURGERY POWER CALCULATION METHODS BY CATEGORY (INCOMPLETE LIST)

Methods that require preoperative keratometry	Methods that do not require preoperative keratometry	Methods that require neither preoperative keratometry nor refraction	Methods that require specialized equipment
• Historical Method • Feiz-Mannis Method[7] • Walter Method[8] • Aramberri Double-K Method[9]	• Koch Method[10] • Masket Method[11] • Latkany Flat-K Method[12] • Latkany Average-K Method[12] • Feiz-Mannis Nomogram[13]	• Shammas No-History Method[14] • R Factor[15] • Haigis-L Method[16] • Mackool Aphakic Refraction Method[17]	• Contact Lens Over-Refraction Method • Orbscan Method[18] • Pentacam Method • Adjusted Effective Refractive Power (EyeSys) • Ray Tracing Method (Okulix) • Ianchulev Aphakic Autorefraction Method[19] • Pachymetric Ratio[20]

The advantages of an online tool are numerous.

Cost. For most surgeons, cost is a crucial factor. Specialized equipment is often prohibitively expensive for the average surgeon, and some calculation methods can be labor-intensive. One method requires an aphakic refraction to be done after lens extraction and prior to IOL insertion, creating a second trip to the operating room. Third-party software programs such as the Holladay IOL Consultant Software and Surgical Outcomes Assessment (Holladay Consulting) have some built-in functionality for post-LASIK calculations, but licensing fees can be expensive to maintain. By contrast, online calculators are free to access and relatively easy to use.

More than one power calculation can be used. Another important advantage is the ability to perform calculations using numerous methods. The OcularMD calculator uses up to 11 methods (Figure 2), and the ASCRS calculator uses up to seven and increases to 12 if data from specific topographers are available. The OcularMD calculator uses the SRK/T, Holladay, and Haigis formulas; the ASCRS calculator uses only the Holladay formula. Both calculators provide an average of the results, which has been shown to increase accuracy over using a single method alone.

Easy to update. Online calculators are more easily updated and, therefore, are updated more frequently. Unlike desktop- or instrument-based software that requires installation at each computer or instrument, online calculators can be constantly improved behind the scenes, incorporating the latest methods as they are published.

The ability to track outcomes. The biggest advantage of online calculators is the ability to track postcataract outcomes; the OcularMD calculator is unique in this regard. By signing up for a free account, the surgeon can save patient data securely for future access. After cataract surgery, the refractive outcome data can be added as well. As new data are obtained, statistical benchmarks are periodically updated to allow surgeons to compare the various methods. This calculator is designed to make data collection as easy as possible so that each surgeon can contribute to increasing our understanding and the accuracy of our IOL calculations after refractive surgery.

TAKE-HOME MESSAGE

- When deciding on a method for IOL calculation, Web-based calculators are one cost-effective option.
- Regardless of the chosen calculation, compare keratometry measurements from several sources and measure multiple times.

CALCULATION PEARLS

The accuracy of any calculation depends on the quality of the data being input, and no calculator is a substitute for common sense. Below are several suggestions that can help ensure better results:

- When performing a set of calculations, ask yourself if the data make sense. The OcularMD calculator includes a set of summary metrics to aid in this evaluation. A rule of thumb is that, for every 1.00 D of refractive change, the cornea changes by 0.70 D. The change ratio (ie, change in corneal power divided by change in refractive power) should be close to ±0.70, although some variation does exist.
- Compare keratometry measurements from several sources (eg, autokeratometer, manual keratometer, topography, biometer) and measure multiple times to make sure the results are consistent. If the keratometry measurements have changed since the post-

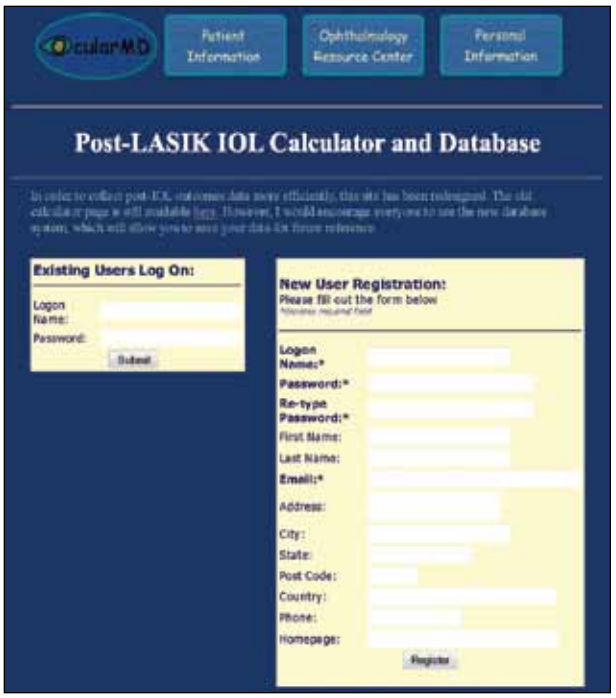
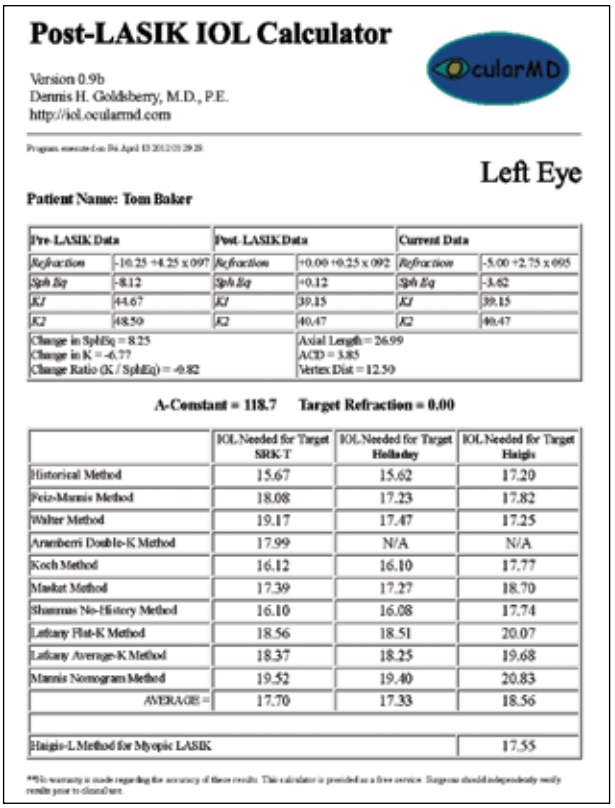


Figure 1. Login page from the OcularMD IOL Calculator.



Post-LASIK IOL Calculator

Version 0.9b
Dennis H. Goldsberry, M.D., P.E.
http://iol.ocularmd.com

OcularMD

Left Eye

Patient Name: Tom Baker

Pre-LASIK Data		Post-LASIK Data		Current Data	
Refraction	-10.25 +4.25 x 097	*Refraction*	+0.00 +0.25 x 092	*Refraction*	-5.00 +2.75 x 095
Sph Eq	-8.12	*Sph Eq*	+0.12	*Sph Eq*	-3.62
K1	44.67	*K1*	39.15	*K1*	39.15
K2	48.50	*K2*	40.47	*K2*	40.47
Change in SphEq = 8.25 Change in K = -6.77 Change Ratio (K / SphEq) = -0.82			Axial Length = 26.99 ACD = 3.85 Vertex Dist = 12.50		

A-Constant = 118.7 Target Refraction = 0.00

	IOL Needed for Target SRK-T	IOL Needed for Target Holladay	IOL Needed for Target Haigis
Historical Method	15.67	15.62	17.20
Feiz-Mannis Method	18.08	17.23	17.82
Walter Method	19.17	17.47	17.25
Aramberri Double-K Method	17.99	N/A	N/A
Koch Method	16.12	16.10	17.77
Masket Method	17.39	17.27	18.70
Shammas No-History Method	16.10	16.08	17.74
Latkany Flat-K Method	18.56	18.51	20.07
Latkany Average-K Method	18.37	18.25	19.68
Mannis Nomogram Method	19.52	19.40	20.83
AVERAGE =	17.70	17.33	18.56
Haigis-L Method for Myopic LASIK			17.55

Figure 2. Sample output from the OcularMD IOL Calculator.

LASIK keratometry, figure out why.

- Consider performing your own measurements rather than delegating them to a technician.
- Double-check the numbers to make sure a transcription error was not made. It is easy to look at the wrong set of measurements when dealing with a thick set of old records. It is important to note whether refractions are written in plus or minus cylinder notation (however, the calculators will accept either). Scan the final output from the calculator to make sure the numbers match, and make sure the data are all from the correct eye.
- Look at the final output and see what makes sense. Often there is one method that is a clear outlier from the others; if so, throw it out.
- There is no substitute for a thorough discussion with the patient regarding the difficulty of IOL calculations in the presence of prior refractive surgery and the risks of a postoperative refractive surprise. A little chair time can go a long way. ■

Dennis H. Goldsberry, MD, PE, FACS, is in private practice with North Texas EyeMD in Frisco, Texas. The free OcularMD IOL calculator presented herein is available on Dr. Goldsberry's personal Web site, www.OcularMD.com. Dr. Goldsberry states that he has no financial interest in the products or companies mentioned. He may be reached at tel: +1 972 215 7500; e-mail: DrG@ntxeye.com.

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