The Effect of Testing Distance on Intraocular Lens Power Calculation

The calculation of the intraocular lens (IOL) power required for a specific patient typically uses a “lens constant” back-calculated from the refractive outcomes of earlier surgical results. An early recommendation was for clinicians to personalize their own lens constants to address systematic errors. However, the introduction of phacoemulsification equipment, continuous curvilinear capsulorhexis, modern foldable IOLs, and non-contact optical measurements of the eye has led to small-incision surgery methods that vary little between surgeons. IOL power calculations and lens constants have therefore become broadly similar between clinics, and it has become possible, in principle, to pool clinical results to arrive at global mean values for lens constants. This approach is particularly useful when a new lens model is introduced because data from far fewer patients per surgeon are needed and most new users can potentially start with a value that is already almost optimized.

However, something that was never standardized is the test distance used for refraction. The traditional test distance for far vision and refraction is 6 m (20 ft). This goes back 150 years to the work of Snellen, Donders, and other authors, with “6/6” and “20/20” being universally accepted as indications of excellent vision. The upper number in the “Snellen fraction” denotes the actual test distance for a chart that has a minimum feature size for this acuity of 1 minute of arc (although this distance parameter is not always specified in published data). In practice, there is an ambiguity because the entire region from 4 m to infinity is assumed to represent “distance vision,” which means that not all refractive data have the same basis. Furthermore, IOL standards indicate that refractions at 4 m should be adjusted to infinity rather than to the standard test distance when measurements are made during a clinical study.

The effect of the test distance on the measured refraction is illustrated schematically in Figure 1 for eyes having their far points at infinity or 6 or 4 m. The differences are relatively small, but a refraction change of 0.25 diopter (D) typically represents a 0.4-D change in the A-constant because the IOL is located deep in the eye. The lens constant is averaged over many patients and its potential accuracy is much higher than the refraction accuracy for a single patient.

We suggest that testing distances and “least minus” refractions be standardized to 6 m so that different data sets can be placed on a common basis. This also has the advantage of leaving the eyes slightly myopic, allowing pseudophakes to make full use of their available depth-of-focus to attain satisfactory far and intermediate vision. Refractions at other test distances can be converted to standard 6-m values by adjusting for the vergence distance by adding (1/6 – 1/[test distance in meters]) to the spherical equivalent refraction. A value of -0.08 D would be added to the spherical equivalent for measurements at 4 m and +0.17 D to refractions corresponding to infinity to convert them to 6-m values.

REFERENCES

Michael J. Simpson, PhD
Arlington, Texas
W. Neil Charman, PhD
Manchester, UK

The authors have no financial or proprietary interest in the materials presented herein.

doi:10.3928/1081597X-20141021-01

Figure 1. Schematic representation of refraction values for distance vision tested at different distances. Three cases are considered where the eyes have far points at infinity or 6 or 4 m.