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AAO Focal Points
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A-scan Biometry and IOL Calculations

1. The "gain" of the ultrasonic instrument is similar to the volume control on your stereo, there are only rare occasions when "maximum" is necessary, e.g., extremely dense brunescent cataract in which one cannot get a retinal echo with standard settings. In most patients, however, setting the A-scan to maximum will lead to spurious measurements that cannot be trusted. Routinely using the maximum gain leads to errors in which the measurements are too short. This occurs because the trailing edge of the initial burst of sound and the leading edge of the retinal spike move closer together causing a shorter reading. The goal is to adjust the gain such that the retinal spikes are at a maximum, but have not been "clipped" off at the top.

2. The "automatic" mode in an A-scan simply uses standard settings for gain, gates and detection thresholds. It is difficult to generalize about this setting for every A-scan, since they are different for every instrument. In most cases a well-trained technician that knows the proper alignment methods and endpoints to recognize on the oscilloscope screen does a better job than using automatic settings. Our measurements are always made in manual mode and sometimes double checked using the automatic mode. The automatic mode should never be used alone without examining the spikes and gates on the oscilloscope screen to be certain the endpoints are correct.

3. A patient should discontinue their contact lenses until their K-readings are stable. For most patients this takes a minimum of 3 weeks, but I have had some rigid contact lens wearers whose corneas took 2 months to stabilize. The contacts may cause temporary steepening or flattening so the error will be unpredictable. The error in the K-readings induced by the contact lenses is diopter for diopter in the final postoperative refraction. I have seen a 2.5 diopter change in some patients.

4. There are two methods for measuring the power of an intraocular lens once is has been explanted:

1) Measurement in air. The intraocular lens may be measured in air with a lensometer capable of measuring powers in air up to 90 diopters. It must be remember that a PMMA lens will appear 3.18 times as strong in air as it does in aqueous. A PMMA lens that is measured to be 63.6 diopters in air is actually 20.0 diopters in aqueous. This method is used by most manufacturers in their quality control of the lenses. Most clinicians, however, do not have these sophisticated lensometers, making this method impractical or too costly.

2) Measurement in water. If the implant is placed in a water bath, such as those available for soft contact lenses, the power may be measured directly. If the lens is placed in a water cell that has flat surfaces and is thin (less than 4 or 5 mm thick), the lens can be measured on a standard lensometer that measures up to 30 diopters. If the lensometer only measures to 20 diopters, than a minus 5 or 10 diopter lens can be interposed between the lensometer and the water cell so that 5 or 10 diopters can be added to the reading, e.g. if the lens measures 20 diopters with a -10 diopters lens interposed, the lens is actually 30 diopters in power. Although this method can be accurate to 0.25 diopters, for clinical measurements, it is usually within 1 or 2 diopters of the labeled value, which is sufficient to determine large refractive surprises. For more

accurate values, extreme care with vertex distances, thickness of the water cell, and converting from posterior vertex power to effective power must be considered.

5. A lens may be measured in the eye comparing the size of the Purkinje-Sanson images from the intraocular lens to the size of the first Purkinje-Sanson image from the cornea at the slit lamp.[1] For convexoplano lenses, the referenced article gives several tables for various K-readings, position of the lens within the eye (effective lens position), and ratio of the lens reflection to the corneal reflex.

For biconvex lenses, the number of combinations are far too great to create tables. One can only measure the front surface, then look at the manufacturers combination of powers for their lenses on the back and front surface and infer the power. This method works well provided the manufacturer does not fix the front surface power and only change the back surface. If this is the case the lens must be measured after explantation at surgery.

6. Most studies comparing the same style lens in-the-bag and in-the-sulcus, show the sulcus fixated lens to be approximately 0.25 mm anterior. The effective power of the lens in the posterior chamber is approximately 1.9 diopters per mm displacement. The lens in the sulcus will therefore induce approximately 0.50 diopters more myopia than intended. The exact difference depends on lens compression characteristics with vaulting, biconvex design, and the power of the lens. The higher the power of the lens the more significant the position of the lens. For low powered lenses (less than 10 diopters), the effect is negligible.

If the surgeon has a lens for the bag only, a back-up lens for sulcus fixation should be taken to surgery, and both power calculations performed. If the lens can be used in the bag or sulcus, the measurement errors in A-scan, keratometry, and patient variation do not require a second set of lenses.

7. There are three methods, other than manual or automated keratometers, for determining the proper K-readings for IOL calculations in patients who have had keratorefractive surgery prior to the development of a cataract: 1) calculated method, 2) contact lens method and 3) refractive power measurements from corneal topography.[2]

Calculated method: Subtract the change in refraction from the keratorefractive procedure, vertexed to the cornea, from the average value of the k-readings prior to the procedure. For example, a patient with a -4.00 diopter refraction and k-readings of 44.00 diopters prior to RK, who became plano 2 to 3 months after the surgery, would have a "calculated K" of 40.00 diopters. Refractions over 4 diopters must be vertexed to the cornea and care must be taken not to take the refraction too soon after surgery, before the cornea has stabilized and not too long after surgery when some of the refractive changes may be due to the cataract. This method is usually very accurate, but requires k-readings and the change in refraction from the keratorefractive procedure which are not always available.

Contact lens method: This method requires placing a rigid contact lens on the patient with a know base curve and plano refractive power and determining the change in the spheroequivalent refraction with and without the contact lens. If the base curve of the plano contact lens is equal to the average power of the cornea there will be know change in the spheroequivalent of the refraction. If the patient were one diopter more myopic with the contact lens than without, the lens is 1 diopter stronger than the cornea. For example, if a patients spheroequivalent refraction

were -2.00 diopters with no contact lens, and became -3.00 with a contact lens with a base curve of 40.00 diopters and plano power, the cornea must be one diopter weaker than the contact lens, or 39.00 diopters. Any refractions greater that 4 diopters must be vertexed back to the corneal plane to avoid error due to vertex distances. This method works very well provided the vision is adequate to determine a reliable refraction (no worse than 20/80), and the contact lens does not cause excessive tearing causing extreme variability in the refraction with the contact.

Central power calculation from corneal topography: Within 1 year most of the corneal topography manufacturers will have software that will calculate the effective spheroequivalent power of the central zone of an irregular cornea. It is already available from some manufacturers. All of the corneal topography instruments measure thousands of points within the central 3 mm zone of the cornea, yielding a much more reliable measurement than the four point measured with the manual or automated keratometer. One should avoid the standard measurements from the manual or automated keratometers, because they are usually measuring near the edge of the optical zone where the cornea is changing dramatically. The keratometric samples are insufficient to give reliable values and can lead to significant refractive surprises.

It is also know that the cornea will undergo changes following the cataract procedure similar to those experienced after the initial RK, i.e. a hyperopic shift on the first day after surgery with a gradual decrease of a few days to weeks.[3] One should not be concerned with 2 to 3 diopters of hyperopia, the first few days after the cataract surgery. DO NOT PERFORM A LENS EXCHANGE, WAIT A FEW DAYS AND THE HYPEROPIA WILL SUBSIDE. It is also very important that a third generation formula be used in these cases, as with any unusual eye, such as the Holladay, SRK/T, Olsen, or Hoffer Q since older formulas such as the SRK I, SRK II, and Binkhorst can make significant unnecessary errors.[4]

8. The is no specific formula for determining the implant power, although Gordon showed the general change in ocular parameters with age.[5] The eye undergoes "emmetropization" in most cases, causing the cornea to flatten, the axial length to increase and the crystalline lens power to decrease. I recommend targeting for emmetropia and realizing in some of the patients there will be a myopic shift over time. This situation assures, that the patient will have some "real" far point that he can see without glasses during the amblyogenic period. In short, it is better to be emmetropic as a baby and become myopic as an adult, with minimal amblyopia, than to be 3 diopters hyperopic as a baby and become emmetropic when your are an adult and be amblyopic.

9. It is still important to measure the axial length in both eyes, even when one already has an implant. The pseudophakic eye must be measured at the aphakic velocity (1532 m/sec), however, then adding 0.4 mm to the measured length for PMMA lenses, or subtracting 0.8 mm for silicone lenses.[6,7] The actual axial length should always be with 0.3 mm of each other. If this procedure is followed, axial length measurement problems should be minimal, except in extremely long axial myopic patients in which the posterior staphyloma can cause significant errors in ultrasonography. A +1.50 diopter error, when the axial length is correct, is usually a result of cumulative error in the measurements. The cornea is slightly steepened by the surgery, the lens is 0.1 mm more anterior than predicted, the lens is 0.25 diopters more than the labeled power and the patient's true retinal thickness is less than 250 microns. For these reasons, in a second eye done by the same surgeon with the same lens and operation, one should adjust the power in the second eye by the results in the first. For example, if the patient was target for plano and the final postoperative

refraction was -1.50 diopters and the other eye is almost identical, use a lens from the original calculation in which the lens has a predicted refraction of +1.00 diopters. This usually gets the patients nearer emmetropia and does not cause a significant anisometropia for the patient.[8]

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