IOL Calcs I: Basics

- Quick, down-and-dirty estimate of IOL needed for emmetropia: *Power =* # + (# *x pre-op* abb. *)*

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- Quick, down-and-dirty estimate of IOL needed for emmetropia: *Power* = *18* + (*1.6* *x pre-op* *S.E.*)

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  - [ ]: Based on linear regression of refractive data
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With regar...
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*Speaking of longer eyes: If an eye has an AL > 25 mm, what pathological state **must** be ruled out prior to IOL selection?*

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Why do staphyloma produce variability among AL measurements?
Because measurement signals directed at a staphyloma often vary in where along the (sloping) wall they reflect, and thus each signal will yield a different AL

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What specifically is meant by stating the SRK was 'too inaccurate'?

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What specifically is meant by stating the SRK was 'too inaccurate'?
SRK worked well for eyes of average length and keratometry; however, it often led to large 'refractive surprises' in eyes that were significantly shorter or longer than average

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How does SRK/T differ from SRK1 and SRK2?

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  - **Was replaced by SRK2 , which was replaced by SRK/T**

IOL Calcs I: Basics

What specifically is meant by stating the SRK was 'too inaccurate'?
SRK worked well for eyes of average length and keratometry; however, it often led to large 'refractive surprises' in eyes that were significantly shorter or longer than average

How was this inaccuracy addressed in the SRK2?
An *A* constant adjustment was performed, based on axial length

How did this work out?
SRK2 was an improvement, but was ultimately deemed not accurate enough as well

How does SRK/T differ from SRK1 and SRK2?
The fundamental difference is that SRK1 and 2 were empiric formulae, derived by crunching the numbers for many CE cases. SRK/T is a theoretic formula (that's what the 'T' is for).

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(Warning--Optics nerd-out right ahead)
More precisely, ELP is the distance between the **principal planes** *of the cornea and IOL.*

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Which step in phaco surgery is most critical in determining **actual** *ELP (i.e., where the IOL will be seated within the eye)?*

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Increased accuracy in IOL calc formulae are due to improvements in ELP estimation.

Which step in phaco surgery is most critical in determining **actual** *ELP (i.e., where the IOL will be seated within the eye)?*
Assuming capsular bag placement, the most critical step is the **capsulorrhexis**. A continuous, centered rhexis that covers the entire optic will hold the IOL in the location where the IOL calc formula 'expects' it to be. In this way, estimated ELP and actual ELP stand the greatest chance of being equivalent—and thus the intended post-op refraction and the obtained post-op refraction are more likely to be equivalent as well.

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IOL Calcs II: Theoretic Formulae

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Does this mean these formulae employ ***no*** *empirical information?*

IOL Calcs II: Theoretic Formulae

Does this mean these formulae employ **no** *empirical information?*
No—all of these will rely on study-based estimates of certain anatomic considerations (eg, axial length). <u>What makes them ‘theoretic’ is their inclusion of non-empirical factors.</u>

IOL Calcs II: Theoretic Formulae

- 1st generation theoretic formula
  - Assumed ELP was # mm for all patients

IOL Calcs II: Theoretic Formulae

- 1st generation theoretic formula
  - Assumed ELP was 4.0 mm for all patients

IOL Calcs II: Theoretic Formulae

- 1st generation theoretic formula
  - Assumed ELP was 4.0 mm for all patients
- 2nd generation # -variable theoretic formula

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IOL Calcs II: Theoretic Formulae

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  - As
- These are of **historic interest only**—no one uses them anymore
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  - three well-known 3rd gen formulas
  -
  -

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Measure specific variable(s) to estimate ELP

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(SRK/T, Holladay I, Hoffer Q:) Measure both AL and keratometry to estimate ELP

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  } Measure specific variable, as well as several other factors +/- variables used by the 3rd generation formulae above, to estimate ELP

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So which of these is the best?

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What constitutes 'relatively normal' for AL and Ks?
Depends upon whom you ask. Dr. Jack Holladay recommends limiting their use to eyes with AL of 22 – 25mm and Ks of 42 – 46D. Dr. Warren Hill uses limits of 22.5 – 26mm and 41 – 46D.

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Why don't these formulae work for eyes outside these values?

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So what formula should be used for eyes such as these?
Both *Holladay II* and *Haigis* work very well for these eyes

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- 1st generation theoretic formula
  - Assumed ELP was 4.0 mm for all patients
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- 4th generation multi-variable theoretic formulae
  - *Holladay II*
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  } Measure anterior chamber depth (ACD), as well as several other factors +/- variables used by the 3rd generation formulae above, to estimate ELP
- 5th generation multi-variable theoretic formula
  - *Hoffer H-5* — Equivalent to Holladay II, except employs [demographic factor 1] and [demographic factor 2]-specific averages for AL, corneal power, etc.

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IOL Calcs III: ***s/p Keratorefractive Surgery***

Note—topic shift

IOL Calcs III: s/p Keratorefractive Surgery

- Prior keratorefractive surgery renders IOL calcs difficult in two ways. What are they?
  1) Measurement of…
  2) Estimation of…

IOL Calcs III: s/p Keratorefractive Surgery

- Prior keratorefractive surgery renders IOL calcs difficult in two ways. What are they?
  1) Measurement of…**central corneal power**
  2) Estimation of…**ELP**

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Why is measurement of central corneal power problematic after keratorefractive surgery?

IOL Calcs III: s/p Keratorefractive Surgery

- Prior keratorefractive surgery renders IOL calcs difficult in two ways. What are they?

  1) Measurement of…**central corneal power**

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Why is measurement of central corneal power problematic after keratorefractive surgery?
The problem lies with manual keratometry. To perform reliable IOL calcs, we need an accurate measure of central corneal power. However, contrary to popular belief, manual keratometers do **not** measure central corneal power.

IOL Calcs III: s/p Keratorefractive Surgery

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The problem lies with manual keratometry. To perform reliable IOL calcs, we need an accurate measure of central corneal power. However, contrary to popular belief, manual keratometers do **not** measure central corneal power. Instead, they determine the curvature of the anterior corneal surface at a ring ~3 mm in diameter surrounding the central cornea. This value is then used to *estimate* the central corneal power.

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Hard CL overrefraction method: A plano hard contact lens is used to restore the cornea to its pre-surgical configuration. The CL will vault over the flattened central cornea, and the tear film will fill in the portion altered by the refractive surgery. The patient is refracted with and without the CL in place, and the difference between these refractions equals the change in the cornea owing to the refractive surgery. This change is then added to the base curve of the CL to yield an estimate of the central corneal power. This technique may be too unreliable, however.

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Automated keratometry/topography: These devices can do a fair job of estimating anterior corneal power (though adjustments and modifications are frequently needed). Thus they can yield reasonably accurate estimates of corneal power in post-RK and post-hyperopic ablative corneas, because these surgeries do not alter the relationship between the anterior and posterior corneal curvatures. However, because myopic ablative procedures alter the relationship between the anterior and posterior corneal curvatures, keratometry/topography techniques will **not** produce accurate estimates of true central corneal power s/p myopic keratoablative surgery.

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So which is more problematic for getting accurate K power estimation: RK, hyperopic ablative surgery or myopic ablative surgery?

Clearly, a history of prior myopic ablative surgery provides the greatest challenge in estimating central corneal power!

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A plethora of techniques have been developed specifically for estimating central K power after myopic ablative surgery. Some of them make use of historical data (e.g., pre-refractive surgery Ks); these include the *Masket method* and the *corneal bypass method.* Other approaches rely on new technologies for measuring central K power; e.g., techniques involving the Oculus Pentacam.

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Why is estimation of ELP problematic after keratorefractive surgery?
The problem is with the 3rd generation 2-variable (3G2V) theoretic formulae (SRK/T, Hoffer Q and Holladay I) so popular with surgeons. Recall that these formulae rely in part upon corneal power in estimating ELP. Recall also that we now know the assumptions built in to these formulae regarding the relationship b/t corneal power and ELP are ***incorrect***.

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Consider an eye with pre-RK keratometry of 45D and post-RK keratometry of 38D. We know that RK does not affect where an IOL will sit within the eye, and thus will have no effect on ELP. However, 3G2V formulae will yield very different ELP estimates based on a 38D cornea than they would for a 45D cornea because of the erroneous assumptions relating ELP and corneal power.

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For this reason, *obtaining accurate central corneal power after keratorefractive surgery is only half the battle for accurate IOL calculations*—the accurate K powers, once obtained, must be plugged into a formula equipped to handle them!

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The most popular technique is probably the ***double K method*** developed by Aramberri. In this approach, the pre-refractive-surgery Ks are used to determine IOL *position* (i.e., ELP estimation), but the post-refractive-surgery Ks are used to determine IOL *power*.

For this reason, *obtaining accurate central corneal power after keratorefractive surgery is only half the battle for accurate IOL calculations*—the accurate K powers, once obtained, must be **plugged into a formula equipped to handle them!**

IOL Calcs III: s/p Keratorefractive Surgery

- Prior ke[...]OL calcs di[...]ey?
  - 1) Measu[...]
  - 2) Estima[...]

How do these formulae deal with the problem of ELP estimation with post-keratorefractive surgery corneas?

Why is estimation of ELP problematic after keratorefractive surgery?
The problem is with the 3rd generation 2-variable (3G2V) theoretic formulae (SRK/T, Hoffer Q and Holladay I) so popular with surgeons. Recall that these formulae rely in part upon corneal power in[...] formulae[...]

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Which formulae can be used to obtain accurate IOL calcs after keratorefractive surgery?
The clinician has two choices in this regard:
1) use a 3rd generation ***multi***–variable formula (**Holladay II; Haigis**); ***or***
2) use a 3G2V formula, but modify the process to circumvent erroneous ELP estimation

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If pre-surgical Ks are available, the Holladay II employs them (in addition to AC depth and other factors). If they are not available, Holladay II uses a default K power of about 44D in calculating ELP. On the other hand, the **Haigis does not use K values in estimating ELP,** so this is a non-issue for Haigis users.

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