Biometry After Lasik

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Background

Intraocular lens (IOL) implantation after refractive surgery is challenging because standard IOL power formulae can lead to significant unintended postoperative refractive errors. Special methods of IOL calculations should be used in these cases.

Errors with standard formulae

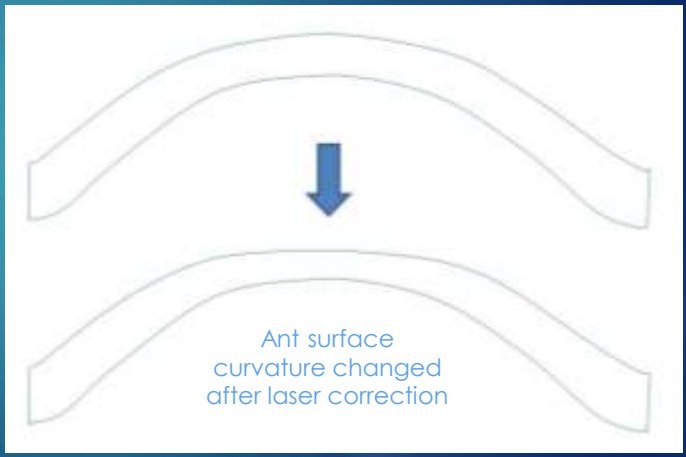
- Currunt formulae are
  - Hoffer Q
  - SRK/T
  - Holladay II
- Ks are used to:
  - Predict postoperative refraction
  - Predict effective lens position "ELP" : the depth of the IOL relative to the cornea

Errors with standard formulae

- Refractive surgery alters the corneal curvature and introduces error into both the measurement of corneal power and the prediction of ELP causing:
  - Underestimation of the required IOL power in eyes that had previous myopic refractive surgery.
  - Overestimation of the required IOL power in eyes that had previous hyperopic refractive surgery.

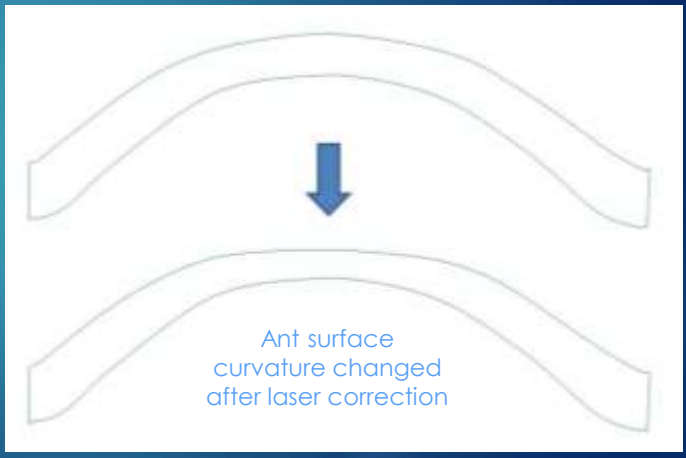
Keratometry Error after Laser Vision Correction (LVC)

- Laser vision correction (LVC) procedures e.g. LASIK and PRK modify only the anterior corneal curvature but leave the posterior curvature unchanged, thereby altering the normal anterior/posterior curvature ratio



Keratometry Error after Laser Vision Correction (LVC)

- Standard keratometry e.g IOL Master measures only the anterior corneal curvature, the posterior curvature is extrapolated based on the normal anterior/posterior curvature ratio.
- This extrapolation is no longer valid after LVC.



ELP error after laser vision correction

- Standard IOL power formulae use the axial length and corneal power to predict the position of the IOL postoperatively.
- Refractive surgery changes the corneal power but not the depth of the lens, leading to an error in ELP prediction in the standard formulae.

Methods to avoid Ks errors

- There are 3 methods to obtain the true corneal power after refractive surgery
  - Clinical history method
  - Topography based post LASIK adjustment
  - Net corneal power measurements

Clinical history method

- K=KPRE-RCC
  - K: calculated corneal power
  - KPRE: corneal power before refractive surgery
  - RCC: change in manifest refraction at the corneal plane
- Advantages:
  - This method theoretically yields the actual corneal power and is easy to calculate if the relevant data are available.
- Disadvantages:
  - Unavailability of the data
  - Inaccuracy of the data
  - Interval changes in the corneal curvature

Topography based post LASIK adjustment

These regression formulas are based on analysis of post-LASIK corneal topography central Ks (TK) in LASIK eyes. True corneal power is predicted using only the single central postoperative reading TK.

- Koch and Wang Formula:
  - $K=1.1141 \times TK - 6.1$
- Shammas Formula
  - $K=1.14 \times TK - 6.8$

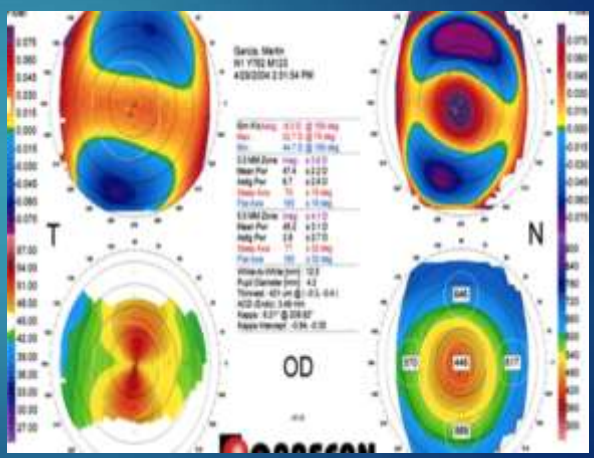
K: calculated corneal power.
TK: post-LASIK corneal topography central Ks

Net corneal power measurements

- The fundamental solution to obtaining accurate post-LVC corneal power is to directly measure both anterior and posterior corneal curvature and thereby calculate the net corneal power.
- Several instruments can directly measure both anterior and posterior corneal surfaces:
  - Orbascan
  - Pentacam
  - OCT

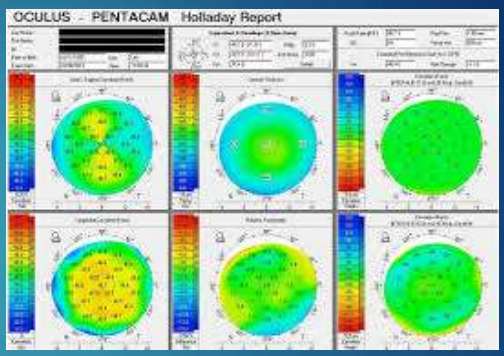
Net corneal power measurements

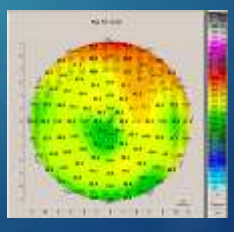
- Orbascan:
  - A limitation of Orbscan elevation maps is that intracorneal opacities may obscure imaging of the posterior cornea and introduce artifacts into total corneal power calculations.
  - Additionally, the reliability of posterior corneal measurements with the Orbscan has not been fully established.



Net corneal power measurements

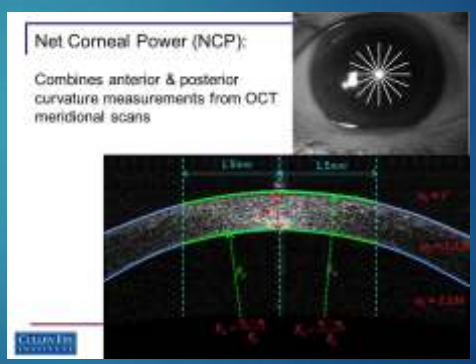
- Pentacam
  - It generates a True Net Power map of the cornea as well as calculates an equivalent K called the Holladay Report.
  - The equivalent K (at the recommended 4.5 mm zone) of the postoperative cornea has been proposed as an accurate measure of the true corneal power.





Net corneal power measurements

- OCT
  - Measure both anterior and posterior corneal power.



Formulae to be used

- Double-K Formulae
- Hoffer Q Formula
- Haigis-L Formula
- Masket Formula
- Koch and Wang Nomogram Adjustment

Formulae to be used

- **Double-K Formulae**
  - In "double-K" version of IOL formula, the post-refractive surgery corneal power reading is used in the vergence calculation while the pre-refractive surgery corneal power (or an estimate of it) is used in the ELP prediction formula.
  - This reduces the error in post-refractive surgery ELP calculation.
  - Double-K versions of SRK/T, Hoffer Q and Holladay II formulae are available.

Formulae to be used

- **Hoffer Q Formula**
  - The Hoffer Q formula estimates a method of ELP calculation that is less sensitive to corneal power variation.
  - Therefore it introduces less error in post-refractive surgery eyes than other single-K formulae.
  - If double-K formulae are not available, the single-K Hoffer-Q formula may be useful.

Formulae to be used

- **Haigis-L Formula**
  - This formula is part of the built-in software of IOL Master.
  - Corneal power is calculated by inputting IOL-Master biometry as follows: axial length (AL), anterior chamber depth (ACD), and keratometry (corneal radii).
  - This formula is a regression formula based on statistics.
  - Accuracy may decrease if the eye is on the edge of normal distribution (high myopic or high hyperopic eyes).

Formulae to be used

- **Masket Formula**
  - *P=PTARG-0.326×RCC -0.101*
    - *PTARG: IOL power calculated by standard IOL formulas*
    - *RCC: surgically induced refractive change*
    - *(SRK/T: myopes; Hoffer Q : hyperopes)*
- This method adjusts the power of the IOL, calculated using the postoperative measured data using the knowledge of the surgically induced refractive change. They recommend using the SRK/T formula for myopic ALs and the Hoffer Q for hyperopic ALs

Formulae to be used

- **Koch and Wang Nomogram Adjustment**
  - Koch and Wang made separate nomograms for both post myopic and hyperopic refractive surgeries.
  - This nomogram is easy to use by just look up the axial length of the patient and add or subtract the adjusted IOL power to the IOL power calculated using the SRK/T, Hoffer Q, and Holladay II formulas.

Take home messages

- Due to many options available, it is better to use more than one method and consider the average or the median recommended IOL power.
- It is wise to hedge in the direction of myopic results.
- Even with the use of many specialized methods, the predictability of refractive outcome of cataract surgery after previous refractive surgery is still not as good as the result in virgin eyes. Therefore patients who had previous refractive surgery should be warned about the potential need for refractive correction after their cataract surgery.

THANK YOU