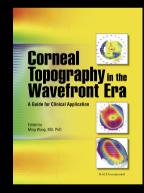
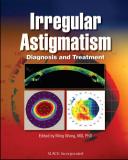
Effect of posterior corneal changes on LASIK

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Posterior corneal surface – a traditionally ignored corneal surface

- Relative small refractive contribution: 12.5%;
- Assumed to be constant in traditional keratometry (hence the constant fudging factor 1.3375, I.e., posterior corneal shape mirrors that of the anterior);
- This assumption was adequate in *pre*-LASIK era.

The change (increase) in posterior cornea contribution can NO LONGER be ignored in LASIK era

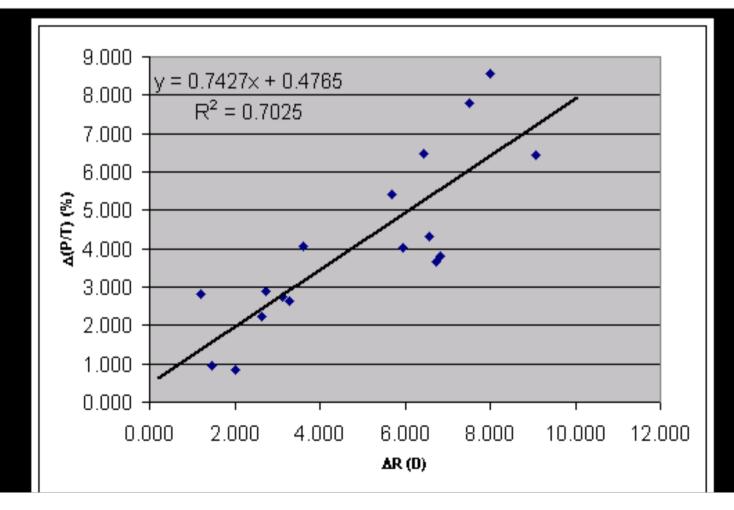
- With the advent of *anterior* ablative corneal surgery, the shape of posterior cornea **no longer mirrors** that of anterior. Posterior contribution to total corneal refractive power is changed (*increased*):
 - "Unilateral "K reduction due to anterior central tissue removal, resulting in a *relative* increase of posterior contribution;
 - Weakening of overall corneal strength due to tissue removal, the posterior surface bulges forward, resulting in an *absolute* increase of posterior contribution.

<u>Question:</u> Does posterior corneal contribution indeed INCREASE after myopic LASIK?

<u>The study:</u> 17 eyes of 17 consecutive myopic patients (-0.74 to -9.98D) s/p LASIK, Orbscan examination of all corneal surface powers.

Yes! Posterior contribution is indeed INCREASED after LASIK (12.5% to 25%)

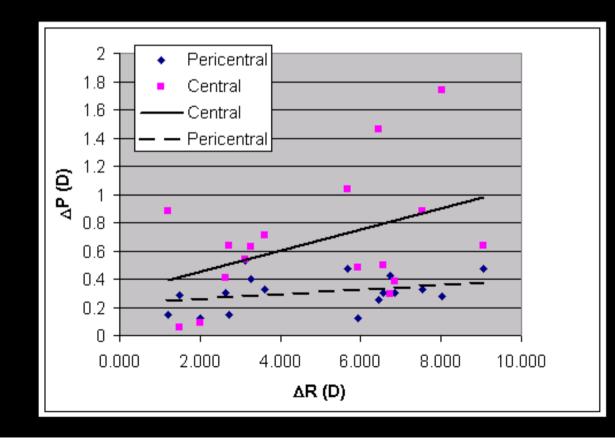
Figure 1: Correlation between change in posterior contribution to total corneal power ($\Delta(P_c/T_c)$) and amount of refractive correction (ΔR) after LASIK



Does central posterior power increases MORE (i.e, more central bowing) than peripheral after myopic LASIK?

Yes, indeed. Central posterior power increases more.

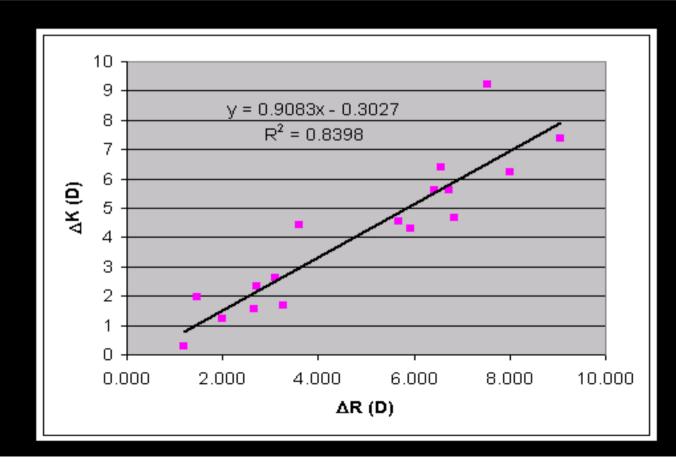
Figure 2: Correlation between change in posterior power centrally (ΔP_c) and pericentrally (ΔP_P) with refractive correction (ΔR)



Is K change a good predictor of refractive correction (at corneal plane), as in the case of pre-LASIK era?

No. K changes is no longer a good predictor. In LASIK, it is less than refractive correction (ratio of 0.8:1).

Figure 3-2: Correlation between change in keratometric central power (ΔK) and refractive correction (ΔR)



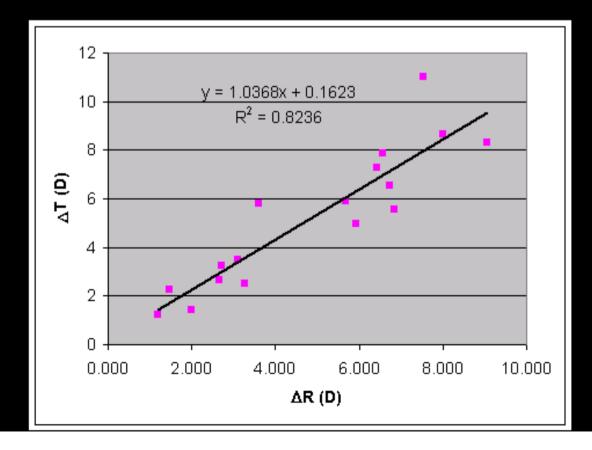
Why is K change less than refractive correction and hence not a good predictor of refractive correction? <u>The answer:</u> K change is less than refractive change is because the posterior contribution is increased after LASIK (K assumes a constant fudging factor 1.3357). If K change is not a good predictor of refractive correction, then what is?

<u>The answer: total corneal power</u> change is the best predictor of refractive correction.

Since in total corneal power change, the changing (increased) posterior contribution after LASIK is taken into account.

Indeed, in LASIK, total corneal power change is the perfect predictor (1:1) of refractive correction.

Figure 3-1: Correlation between change in total central power (ΔT) and refractive correction (ΔR)



Ignoring the change (increase) in posterior contribution is the cause of INACCURACY of IOL calculation in post-LASIK patients

- IOL formulas use traditional K, which assumes that posterior cornea mirrors anterior and is a *constant* contribution (and hence the constant 1.3375 fudging factor);
- Because of this fundamental error in the IOL formula which uses K, "just staying on a more myopic side" to avoid hyperopia is no longer good enough, since the width of scatter of the resultant refraction is also increased.

Posterior contribution is not only increased after LASIK but also posterior surface is the "first surface to go"

- Posterior cornea is the "first surface to go" when cornea begins ectasia:
 - <u>Theoretical consideration</u>: The posterior surface faces the "direct assault" of intraocular fluid forces;
 - <u>Clinical evidence</u>: we often see normal anterior surfaces in the presence of abnormal posterior changes (increased float); however, we seldom see abnormal anterior surfaces *without* accompanying posterior pathology.

Clinical importance in recognizing posterior change before and after LASIK

- <u>Preop:</u> identify early corneal ectasia (posterior ectasia occurs first) and thus exclude these patients;
- <u>Postop:</u> identify early ectasia, in which *excessive* forward movement of posterior cornea ("ominous purple") is present, and thus avoid enhancement.

Posterior changes affect postop visual QUALITY: 1st approximation of corneal refractive surgery

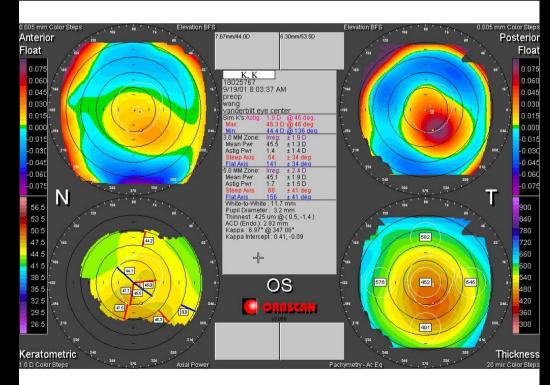
- <u>Anterior surface:</u> determines refraction;
- <u>Posterior surface:</u> determines visual quality - a new frontier in refractive surgery today.

Clinical posterior float threshold for NOT to do LASIK: When there is inferior decentration of float, and the extent of float is: <u>Primary LASIK:</u> 50-80um; <u>Enhancement:</u> 80-100um.

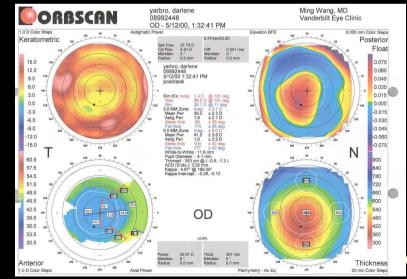
Clinical cases of impact of posterior corneal changes

Case 1: Examination of posterior cornea helps identify poor LASIK candidate: A case of posterior KC "ominous purple"! Posterior change does

occur EARLIER (anterior is still normal).

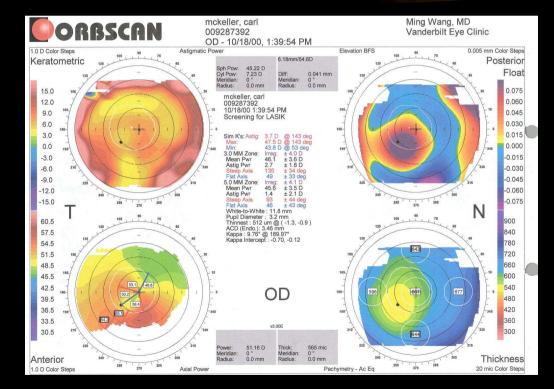


<u>Case 2: Examination of posterior cornea helps identify the</u> <u>true cause of "overcorrection" and thus avoid making</u> <u>things worse by doing enhancement:</u> a case of excessive "overcorrection", which is in fact NOT overcorrection Rather than too much tissue being removed anteriorly, there is a gross forward MOVEMENT of posterior cornea – earliest sign of impending ectasia. Don't enhance. It will result in PAN-CORNEAL thinning with hyperopic enhancement, further worsening ectasia!



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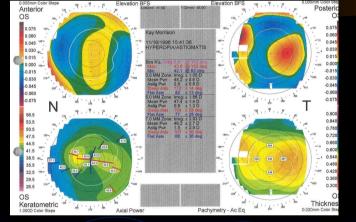
Case 3: Posterior changes occur EARLIER than anterior: a case of anterior change being typically accompanied by posterior changes

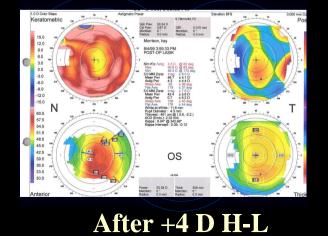


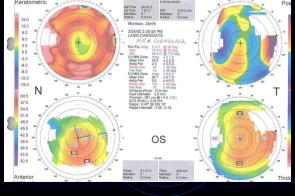
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Case 4: Examination of posterior cornea helps identify the true cause of resistance to enhancment: a case of s/p H-L, resistant to enh, why? Preop existing posterior decentered apex!!!

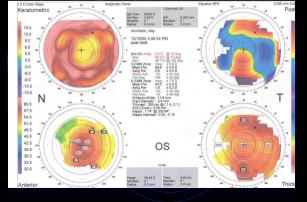
Preop





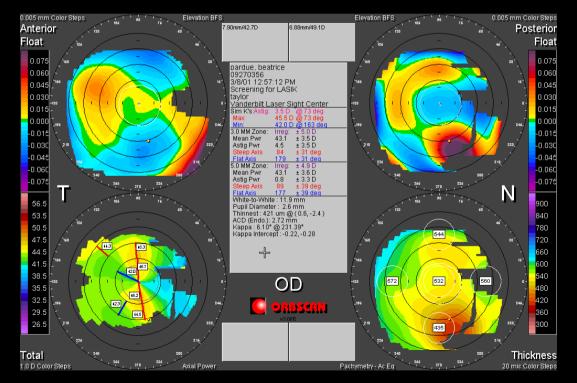


Regressed to +3, after enh

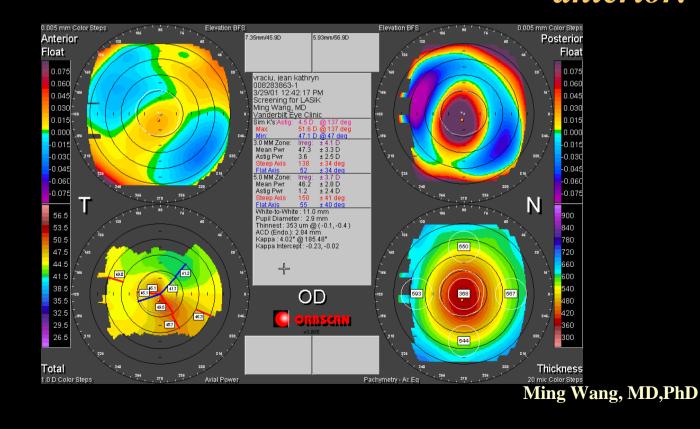


Again reg to +2, after enh

Case 5: Examination of posterior cornea reveals earliest sign of ectasia: A case of posterior KC ("ominous purple"), with normal anterior. Don't touch it!



Case 6: Posterior cornea is an earlier and more sensitive predictor of impending ectasia: a case of posterior change being more pronounced than anterior.



Summary of study of posterior changes after LASIK

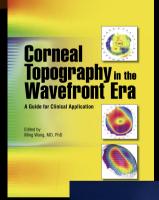
- Posterior corneal contribution to refraction is no longer constant after myopic LASIK, it is in fact INCREASED (12.5% to 25%!);
- K is no longer the best predictor of refractive correction (0.8:1), total corneal power is (1:1);
- Posterior surface is the "first surface to go", and hence is the most sensitive and earliest indicator of impending ectasia.

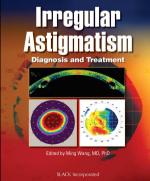
Summary of the effect of posterior contribution increase on IOL

- Not only there is a tendency towards hyperopia, but also the WIDTH of the scatter of the resultant refraction is increased, so it is no longer good enough to "just stay on a more myopic side" to avoid hyperopia;
- <u>Fundamental solution:</u> Reformulate IOL formula to include the changing (*increased*) posterior corneal contribution, I.e.:

Discard the *constant* **fudging factor 1.3375!**

calculation





Topo FFKC criteria 2008

<u>2 D rule:</u>

- > 2D difference in superior and inferior k readings outside the central 3mm;
- > 2D difference in the corresponding inferior corneal locations between two eyes;
- Absolute value of K very high (over 50D) in one eye;

3-point touch:

- Coinciding of location of pathology of ant & post elevation, pachymetry & ant curvature;
- Displaced apex in all maps;

Anterior & posterior float:

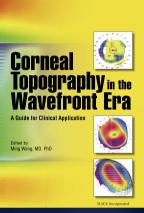
- "Ominous purple" in the posterior surface;
- Anterior 15-20 um;
- Posterior 20-25um (post-LASIK: 40-50um);

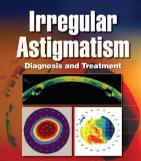
Pachymetry:

- Bed 250-300um;
- Normal: 535um, SD=35um. No LASIK below 1D(500um), no PRK below 2d (465um);
- KC: 430um, SD=70um;
- Thinnest area is more than 15um thinner than center;
- The difference between thinnest areas between 2 eyes is greater than 15-20um;
- Abrupt & more rapid "out-of-zone" pachy increase from thinnest point radially out;

IA orientation, amount, pattern

- > 3D or more dioptic curvature change,,in central 3-mm circle;
- In central 3-mm circle, not regular (bow-tie) pattern; across the pupil 180 degrees,
- change of astigmatism orientation and amount;
- Against-the-rule astig plus inferior steepening, the "C" pattern, suggesting PMD; <u>Topo-based FFKC detectors:</u>
- Tomey: positive KC score with either the KCI or KCS index;
- EyeSys: I-S > 1.3;
- Pentacam: ISV, IVA, KI, CKI, /Rmi, IHA, IHD and ABR
- Humphrey Atlas: Path-finder, in red zone.





Corneal Dystrophy And degenerations A molecular genetic approach

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