

Intraocular Lens Power Calculation in Cases of Anterior Segment OCT Detected Subclinical Posterior Keratoconus

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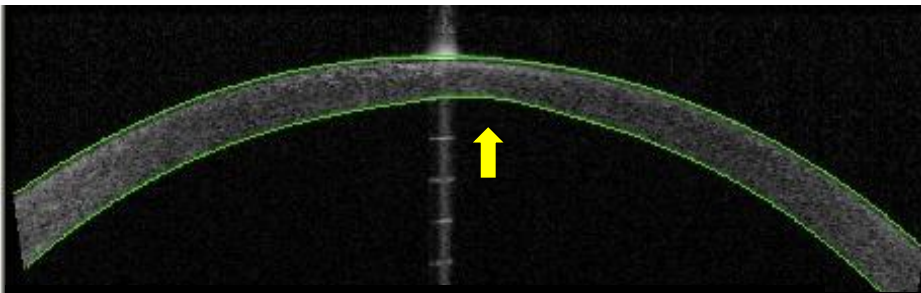
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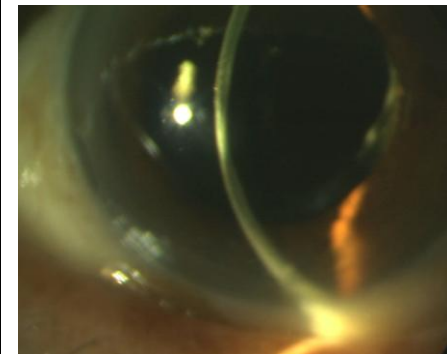
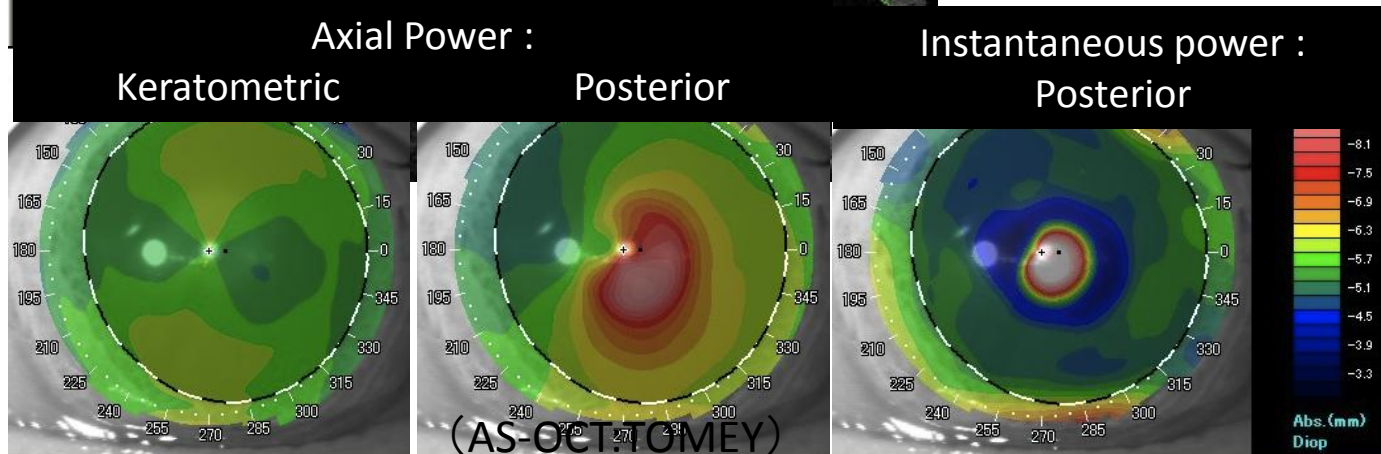
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Posterior Keratoconus

- Localized steep curvature of the posterior corneal surface.
- Developmental anomaly, non-progressive and non-inflammatory.
- Unilateral in many cases, and higher prevalence in females¹⁾.
- Recent advancement of anterior segment OCT can help to diagnose subclinical posterior keratoconus by detecting a characteristic properties of anterior/posterior corneal surface.



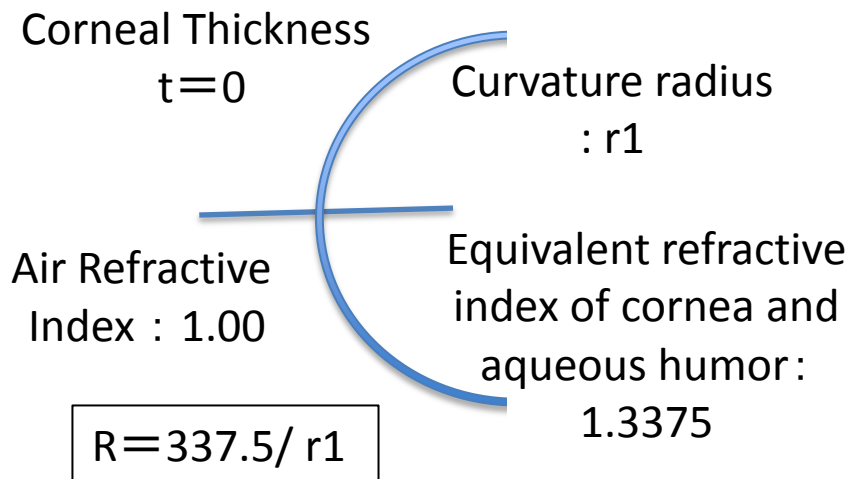
1) Feder RS, Kshetry P: Noninflammatory ectatic disorders. In: Krachmer JH, Mannis MJ, Hollan EJ (eds) : Cornea. 2nd ed. 970-971, CV Mosby, 2005



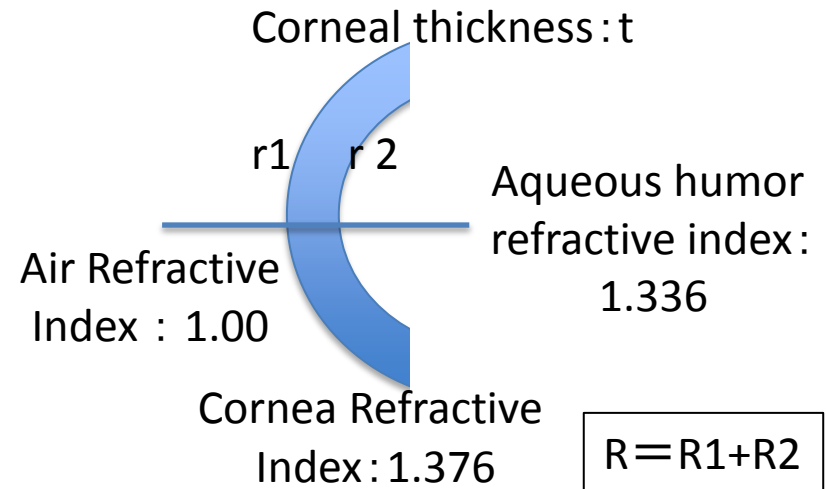
Introduction

- Generally the refractive corneal power is estimated from measured values of the anterior corneal shape using equivalent refractive index of Gullstrand's schematic eye to calculate IOL power. If the anterior to posterior corneal curvature ratio (A/P) is different from the predicted value, there will be a lens power calculation error.

Simplified model using thin lens model

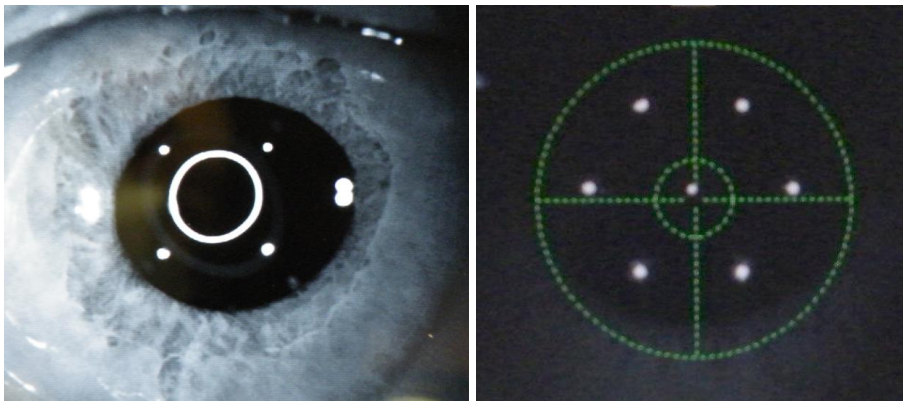


Accurate model using thick lens model

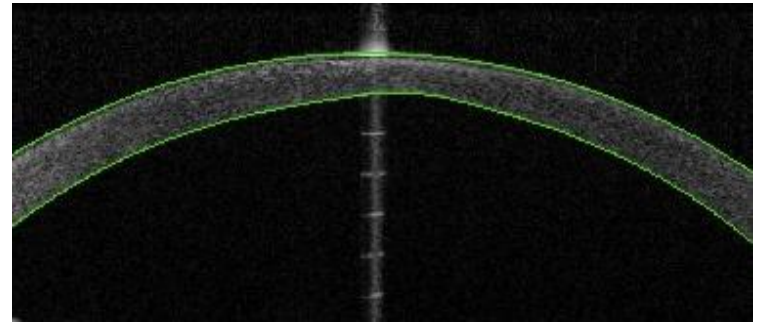


Purpose

To compare intraocular lens power calculation errors in cataract cases with subclinical posterior keratoconus using corneal refractive powers measured by different instruments.



Auto Keratometer



AS-Optical Coherence Tomography

Subjects

- 4 eyes of 4 patients with subclinical posterior keratoconus detected only by anterior segment optical coherence tomography before cataract surgery.
- In all the 4 cases, the IOL was fixed in the bag and there were no intraoperative and postoperative complications.

	Sex	Age	Eye
Case 1	Male	88	Left
Case 2	Male	75	Left
Case 3	Male	79	Left
Case 4	Female	57	Right

Corneal Axial power (sagittal map) and pachymetry map by Anterior Segment OCT

Case 1 : L

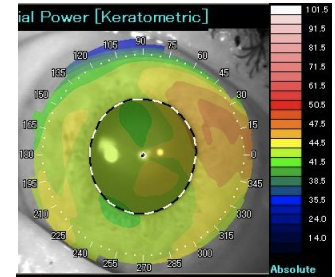
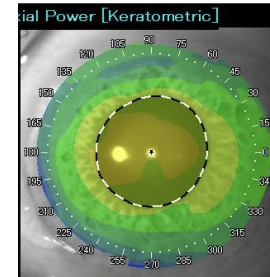
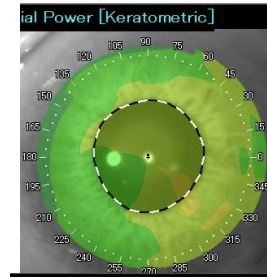
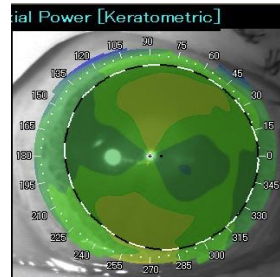
Case 2 : L

Case 3 : L

Case 4 : R

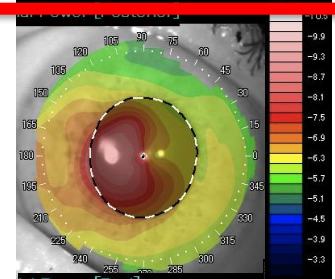
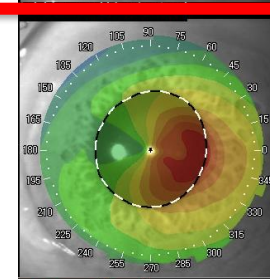
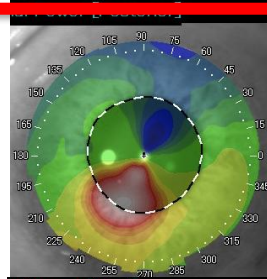
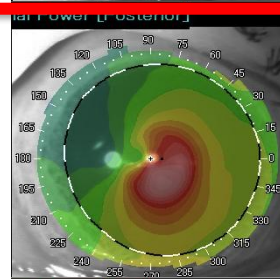
Keratometric

Cornea Equivalent refractive index = 1.3375



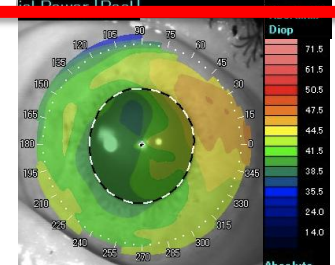
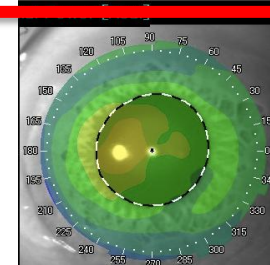
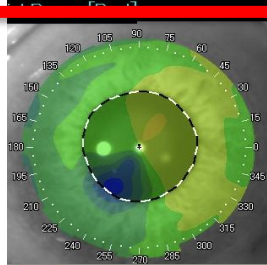
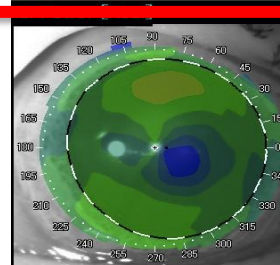
Posterior

The refractive index
Cornea = 1.376
Aqueous humor = 1.336



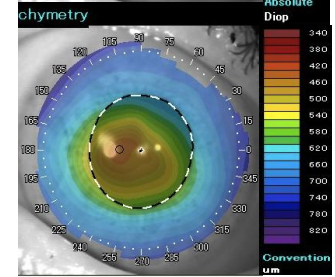
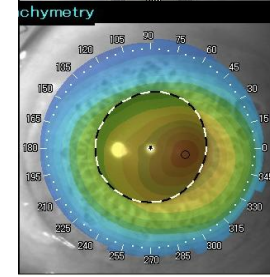
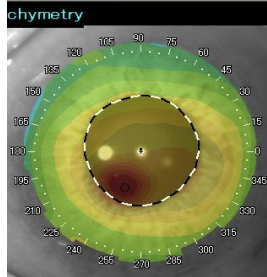
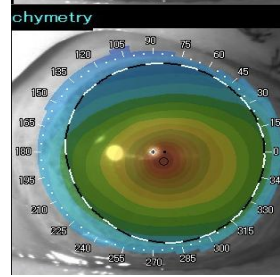
Real

The total power map of both anterior and posterior



Pachymetry

Corneal thickness



Method

- The mean corneal refractive power was measured by different instruments.
- The anterior to posterior corneal curvature ratio (A/P ratio) was measured from the values by AS-OCT.

Instruments	Corneal Refractive Power	Measurement diameter
Auto Keratometer (TONOREF II : NIDEK)	Auto K.	Ø3.3 mm (Anterior R=7.7 mm)
IOLMaster (Carl Zeiss Meditec)	IOLMaster K.	Ø2.5mm (Anterior R=7.8mm)
Anterior Segment OCT (CASIA:TOMEY)	Keratometric	Ø3.0 mm (Independent of corneal curvature)
	Real K. (Total corneal power*)	

*The refractive power is calculated by adding the corneal thickness correction to the sum of anterior and posterior refractive power.

Method

➤ IOL power calculation

- SRK/T formula with optimized A
- Axial length was determined by partial coherence interferometry.

➤ Calculation of postoperative refractive errors

- Predicted refractive errors were calculated from each keratometric values based on postoperative subjective refractive errors.

Results 1.

Mean Corneal Refractive Power Measured by Different Instruments

	Auto keratometer (D)	IOLMaster K. (D)	Anterior Segment OCT (D)		A/P ratio
			Keratometric	Real K.	
Case 1	41.0	40.78	41.0	38.9	1.45
Case 2	42.5	42.31	42.7	41.6	1.26
Case 3	44.25	45.14	44.2	42.9	1.25
Case 4	43.5	43.41	43.3	41.1	1.44

A/P : the anterior to posterior corneal curvature ratio

The Real-K showed smallest value among other corneal refractive powers in all eyes.

Deviation to Real K. : Max. 2.40D Min. 0.71D

In all cases are attributed to significantly higher A/P ratios than Gullstrand Schematic eye or the average normal values (1.19 : Hasegawa et al. Japan Cornea Conference 2013) .

Results 2.

Refractive errors 3 months after cataract surgery.

	Implanted IOL	Axial length (mm)	Refractive error (D)	
		Partial coherence interferometry	IOLMaster K.	Real K.
Case 1	SN6AT5	24.16	1.51	0.10
Case 2	N4-18YG	23.15	0.34	-0.18
Case 3	KS-Ni	23.40	0.97	-0.61
Case 4	KS-AiN	25.97	1.08	-0.65

IOL power calculation : SRK/T (A constant is optimized for IOLMaster)

Discussion

- The A/P ratios in the 4 posterior keratoconus cases were higher than the mean value of 1.19 from 227 eyes with normal corneas (Hasegawa et al. Japan Cornea Conference 2013) and were largely deviated from the A/P ratio of 1.13 from Gullstrand model eye.
- In the eyes with abnormal posterior cornea such as posterior Keratoconus, corneal power calculation based only on the anterior corneal surface overestimates real corneal power.
- When those values were applied to IOL power calculation, the eyes would become hyperopic postoperatively.

Conclusions

- Anterior segment OCT was useful to detect subclinical posterior keratoconus and calculate real corneal power considering both anterior and posterior corneal curvatures.
- Even In subclinical posterior keratoconus cases, IOL power should be carefully calculated by applying real corneal to IOL power calculation.