Pilot Evaluation of a Novel Ray-Tracing-Based Intraocular Lens Power Calculation: The O Formula

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Background

The accuracy of refractive outcome prediction after cataract surgery has been improving; however, even in uncomplicated cataracts, approximately 5% of cases suffer from a prediction error in refraction higher than 1.0 diopter (D).

Melles RB, et al., Ophthalmology. 2018

Kane JX, et al., J Cataract Refract Surg. 2016

In recent years, the evolution of optical biometry with swept-source optical coherence tomography (SS-OCT) technology and anterior segment SS-OCT has substantially improved measurement accuracy.

Mc Alinden C, et al., Am J Ophthalmol. 2017

Fukuda S, et al., Ophthalmology. 2008

Purpose

1. To develop the new **ray-tracing-based** IOL power calculation formula (O formula) using SS-OCT system.

2. To evaluate its accuracy in a series of cataract surgery patients compared with the Barrett Universal II formula (BUII) and the SRK/T formulas.

Methods

Participants: A total of 292 eyes underwent cataract surgery and IOL implantation

- A training set (148 eyes) and a validation set (144 eyes).

Examinations: Pre-op and 1 month post-op

Devices: OA-2000® (TOMEY): SS-OCT-based biometer

CASIA2® (TOMEY): Anterior-segment SS-OCT

OA-2000®

CASIA2®

Surgical technique:

2.2-mm corneal incision and IOL (AcrySof Toric IOL, SN6A T3-T6; Alcon, Fort Worth, TX) were implanted into the capsular bag after phacoemulsification by the same experienced surgeon (T.N.).

This study was approved by the IRB of the National Hospital Organization (R18-161).

The new concepts of O formula

1) Accurate IOL depth

- Prediction of IOL position using angle and lens parameters

2) Accurate axial length

- True geometric path length measured by segmental method using SS-OCT

3) Accurate IOL data

- Actual shape for each IOL power provided by the company

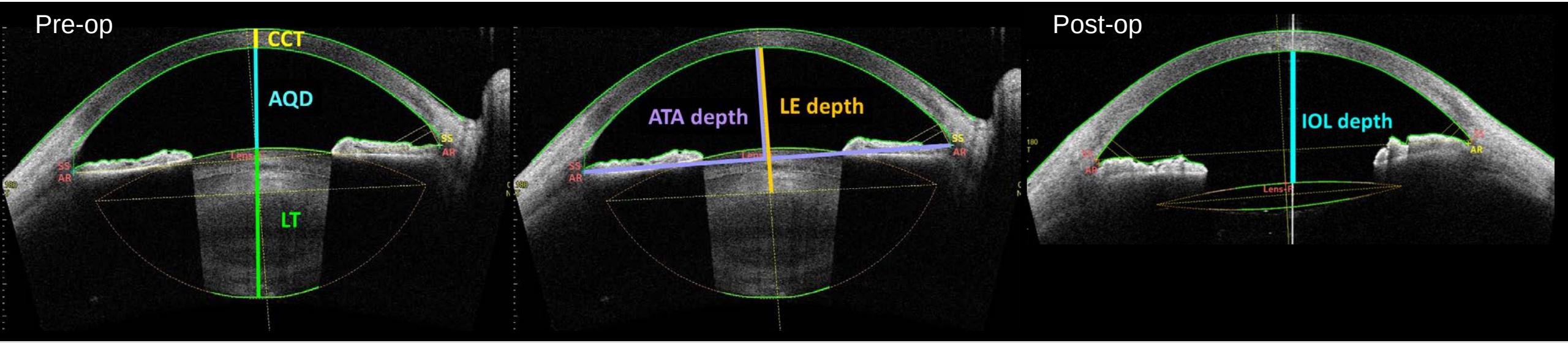
4) Accurate corneal curvature

- Real corneal power using anterior and posterior curvatures, and corneal thickness measured by AS-SS-OCT

The new concepts of O formula

1) Accurate IOL depth

- Prediction of IOL position using angle and lens parameters with OCT image



AQD = aqueous depth, ATA depth = angle-to-angle depth, CCT = central corneal thickness, IOL depth = intraocular lens depth, LE depth = lens equator depth, LT = crystalline lens thickness

Goto S, et al., Ophthalmology 2016

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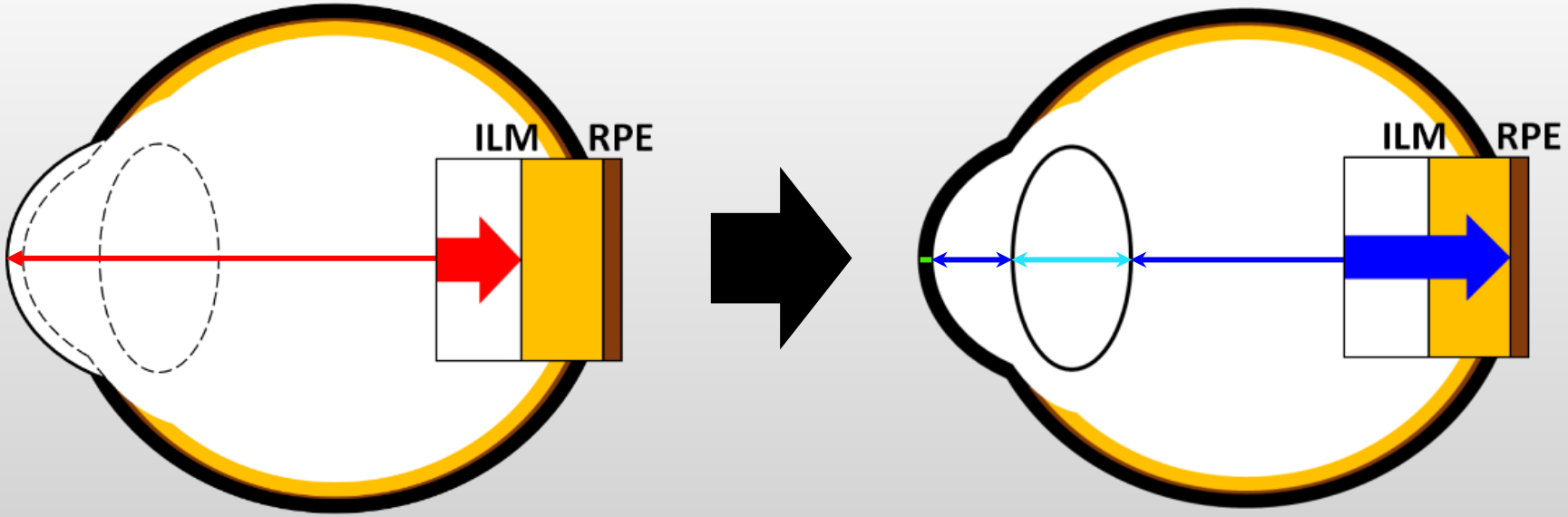

Goto S, et al., Scientific reports & JCRS 2020

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Overall outcomes for the O formula, Barrett Universal II, and SRK/T formula in the training set

					Percentage of Eyes within Diopter Range Indicated (number of eyes)			
Formula	Mean	SD	MAE	MedAE	±0.25 D	±0.50 D	±1.00 D	< 1.00D
O formula	0	0.46	0.37	0.31	58.1% (86)	83.8% (124)	99.3% (147)	0.7% (1)
Barrett Universal II	0	0.46	0.37	0.29	60.8% (90)	82.4% (122)	98.0% (145)	2.0% (3)
SRK/T	0	0.53	0.41	0.37	50.7% (75)	75.7% (112)	96.6% (143)	3.4% (5)

D = diopters, MAE = mean absolute prediction error; MedAE = median absolute prediction error; SD = standard deviation

Overall outcomes for the O formula, Barrett Universal II, and SRK/T formula in the validation set

					Percentage of Eyes within Diopter Range Indicated (number of eyes)			
Formula	Mean	SD	MAE	MedAE	±0.25 D	±0.50 D	±1.00 D	< 1.00D
O formula	0	0.44	0.35	0.29	59.0% (85)	84.7% (122)	100.0% (144)	0.0% (0)
Barrett Universal II	0	0.44	0.34	0.30	64.6% (93)	86.1% (124)	98.6% (142)	1.4% (2)
SRK/T	0	0.46	0.36	0.31	59.7% (86)	84.7% (122)	98.6% (142)	1.4% (2)

D = diopters, MAE = mean absolute prediction error; MedAE = median absolute prediction error; SD = standard deviation

Discussion

The Barrett formula confirmed its reputation as being one of the most accurate, as previously reported. The SRK/T formula is still a valid option.

Kane JX, et al., J Cataract Refract Surg. 2016

Melles RB, et al., Ophthalmology. 2018

Savini, et al., J Cataract Refract Surg. 2020

The O formula had the most accurate MedAE with the highest percentage of eyes within 1.0 D prediction errors.

Conclusion

The O formula is a promising approach for IOL power calculation using SS-OCT-based devices.