SS-OCT Biometers Using Sum-of-Segments versus Mean Group Refractive Index Method to Measure Axial Length

The effect on IOL power calculations.

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INTRODUCTION

Accurate axial length (AL) measurements are an essential element to calculate the precise IOL power. Ever since the introduction of optical biometry, all biometers converted the optical path length to a geometric AL measurement using a Mean Group Refractive Index. A newer approach uses individual refractive indices to measure each segment of the eye, a method referred to as the Sum-of-Segments (SOS).

The SOS method sums up the geometric lengths of each segment in the eye to determine the AL. For each segment, a specific refractive index for conversion from the optical to geometric lengths is used (1.375 for the cornea, 1.336 for the aqueous and vitreous, and 1.41 for the lens). This approach is being utilized by the Argos biometer (Movu Inc.).

On the other hand, the older method applies a Mean Group Refractive Index equivalent to convert the optical into the geometrical AL. The following equation was introduced by Haigis et al[1] for the first IOLMaster biometer: AL = (OPL/1.3549 - 1.3033) / 0.9571. Similar conversion equations are used in other SS-OCT biometers such as in IOLMaster 700 (ZEISS).

The question is, does the AL measurement method make a difference in IOL power calculations?

Several authors have compared SS-OCT biometers (Table 1). In about 50% of the reports, the AL was significantly different between biometers. Significant differences were detected when the AL exceeded an average of 24.08 mm, while no differences were found in eyes that ranged on average from 23.22 to 23.79 mm.

TABLE 1. AL WITH SS-OCT BIOMETERS[1]

Author	Devices tested	# of eyes/patients	AL (mm) Mean ± SD	*P* value
Omoto et al[2]	Argos[2]	106/106	25.14 ± 1.90	<0.001
	IOLMaster 700[3]		25.22 ± 1.95	
Huang et al[3]	Argos[2]	171/119	23.22 ± 0.99	1.000
	IOLMaster 700[3]		23.24 ± 1.02	
Sabatino et al[4]	Argos[2]	218/112	23.78 ± 1.26	0.07
	IOLMaster 700[3]		23.79 ± 1.30	
Yang et al[5]	Argos[2]	146/83	24.19 ± 1.92	<0.001
	IOLMaster 700[3]		24.22 ± 1.96	
Románek et al[6]	Argos[2]	106/57	23.37 ± 1.13	0.941
	IOLMaster 700[3]		23.37 ±1.16	
Montés-Micó[7]	Argos[2]	150/150	24.10 ± 1.34	<0.00014
	IOLMaster 700[3]		24.08 ± 1.38	

[1]Includes AL of short, average and long eyes;[2]SOS; [3]Mean Group Refractive Index;[4]Comparison of 6 biometer

THE IMPACT ON IOL POWER CALCULATIONS

The SOS method may be particularly beneficial for eyes that are shorter or longer than average.[8-10] Omoto et al[2] reported that the IOLMaster 700 measured eyes significantly longer.[2] The prediction error was not significantly impacted, although the percentage of eyes within 0.5 D was consistently higher with Argos in long eyes.[2]

A large analysis performed by Shammas et al[10] investigated the effect of AL determination based on the single refractive index and multiple refractive indices on IOL power calculations in short, average, and long eyes. The AL differed significantly in short and long eyes between methods, and the impact on IOL power calculations was small (Table 2). However, newer formulas may be impacted more significantly

TABLE 2. AL AND PREDICTION ERROR FOR THE SINGLE (SIMULATED DATA) AND MULTIPLE REFRACTIVE INDEX METHOD (MEASURED BY ARGOS)[10]				
			Single	Multiple
Short eyes with AL <22.0 mm (43 eyes)	AL (mm)		21.66 ± 0.31*	21.73 ± 0.30*
	Prediction error within ± 0.5 D (% of eyes)	Barrett UII	65.1	72.1
		Holladay 1	62.8	76.7
		Haigis	60.5	69.8
		Hoffer Q	55.8	67.4
		SRK/T	74.4	72.1
Average eyes with AL of 22 to 25 mm (495 eyes)	AL (mm)		23.50 ± 0.68	23.50 ± 0.07
	Prediction error within ± 0.5 D (% of eyes)	Barrett UII	77.8	80
		Holladay 1	74.7**	78.2**
		Haigis	76.2	78.0
		Hoffer Q	75.4	75.8
		SRK/T	72.3	74.5
Long eyes with AL >25 mm (57 eyes)	AL (mm)		25.80 ± 0.80*	25.71 ± 0.77*
	Prediction error within ± 0.5 D (% of eyes)	Barrett UII	82.5	91.2
		Holladay 1	75.4	80.7
		Haigis	73.7	78.9
		Hoffer Q	70.2	71.9
		SRK/T	75.4	80.7

*P<0.001, **P=0.01

TABLE 3. PREDICTED ERROR WITHIN ± 0.5 D (% OF EYES) IN SHORT AND LONG EYES FOR SELECTED FORMULAS[11]				
	Very short AL ≤22.0 mm (42 eyes)	Short AL <22.5 mm (78 eyes)	Long AL >24.5 mm (102 eyes)	Very long AL ≥25 mm (53 eyes)
Barrett UII	72.1	70.5	83.3	91.2
Barrett TAL	72.4	71.8	82.4	90.6
Hill-RBF	69.1	71.8	82.4	86.8
Hoffer QST	76.2	74.4	80.4	86.8
K6	76.2	79.5	80.4	88.7
Olsen	73.8	79.5	78.4	84.9
Pearl-DGS	76.2	80.8	80.4	83.0
T2	73.8	71.8	81.4	90.6
VRF	76.2	73.1	76.5	77.4
Holladay 1	76.7	71.7	73.5	91.2

when using SOS, and the effect was investigated by calculating the expected residual refractions in a follow up study by Shammas et al.[11] The analysis showed that newer formulas performed equal or better than the traditional formulas with the SOS biometry. For short and very short eyes, K6 and Pearl-DGS performed best, while in long and very long eyes, Barrett Universal II and Barrett True Axial Length provided the highest percentage of eyes within a predicted error within ± 0.5 D (Table 3).

CONCLUSION

AL determined with the Mean Group Refractive Index seems to produce measurements that are slightly shorter in short eyes and longer in long eyes. Depending on the length of the eye, some IOL power calculation formulas may provide better outcomes with the SOS method. ■

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