21 Optical Biometer OA-2000

Naoko Hara, Kathrin Benedikt,
and Hirofumi Owaki

Introduction

Optical biometer OA-2000 (Tomey Corporation, Nagoya Japan) can measure all biometric parameters needed for pre-cataract surgery: axial length, anterior chamber depth, lens thickness, corneal radius of curvature over a 2.5 mm and 3.0 mm diameter, corneal topography, central corneal thickness, pupil diameter, and Corneal Diameter (Fig. 21.1 and Table 21.1). It is done almost automatically by one measurement in short time. The touch screen enables intuitive operation, measurement, data checking, IOL calculation, and data output within one compact

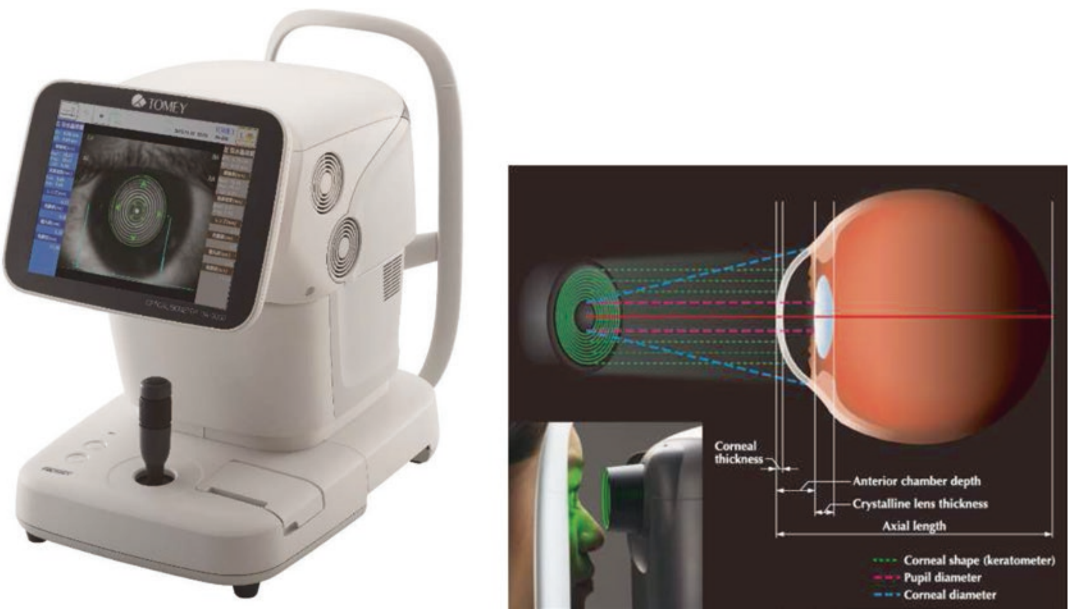

Fig. 21.1 Optical biometer OA-2000

N. Hara · K. Benedikt · H. Owaki (✉)
Tomey Corporation, Aichi, Japan
e-mail: kathrin@tomey.de; matsu@tomey.co.jp

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Table 21.1 Specifications of OA-2000

Measurement method	Axial length Anterior chamber depth Lens thickness Central corneal thickness	Optical low-coherence interferometer using swept-source laser
	Corneal radii Topography	5.5 mm 9 rings Placido ring cone topography
Measurement range	Axial length	14.0–40.0 mm
	Corneal radii	5.0–11.0 mm
	Anterior chamber depth	1.5–7.0 mm
	Lens thickness	0.5–6.0 mm
	Central corneal thickness	0.2–1.2 mm
	Corneal Diameter	7.0–16.0 mm
Display resolution	Axial length	0.01 mm
	Corneal radii	0.01 mm
	Anterior chamber depth	0.01 mm
	Lens thickness	0.01 mm
	Central corneal thickness	1 µm
	Corneal Diameter	0.3 mm
IOL calculation formulae	Standard formulas SRK/T, Holladay, Hoffer Q Haigis optimized, Haigis standard, Olsen, OKULIX [a] Barrett Universal II [b] For toric IOL Olsen Toric Calculator, OKULIX [a] Barrett Toric Calculator [b], Barrett True K Toric Calculator [b] For post-refractive surgery Shammas-PL, Double K SRK/T, OKULIX [a], EASY IOL Barrett True K [b]	

[a] Optional, depending on sales area
[b] Optional

unit. The OA-2000 supports doctors to reduce stress on patients and accurate and smooth preoperative examination and planning for high-quality cataract surgery by these features on daily practice [1].

Axial Length Measurement

The touch-alignment system is employed on OA-2000. It can provide a stable measurement and a high reproducibility between operators because OA-2000 aligns itself automatically to patient eye once an operator only touches the center of the pupil on the screen. Operators can measure all data easily without any special skills (Fig. 21.2) [2].

OA-2000 achieves a high signal–noise ratio (SNR) and high transmitting on opacity parts by using swept-source coherence tomography method. In addition, long coherence length allows high penetration and high success rate on long axial length myopic eyes (Fig. 21.3) [3]. Additionally, OA-2000 obtains not only A-scan wave form but also B-scan image of 1 mm width on retina by 2D scanning. On a measurement result of normal eye (Fig. 21.4), SNR is high and standard deviation (SD) is very low because the measurement light isn't reduced as the crystalline lens is clear. It means the measurement is very stable.

On the other hand, there are some cases where it is difficult to obtain the signal around the center of the retina as shown in Fig. 21.5a. In such case, OA-2000 measures the axial length by detecting a stronger signal from peripheral area automatically. When the retinal signal cannot be detected even with that way, V scan (Fig. 21.6) is performed instead of horizontal scan to find less opacity position so that the retinal signal can be

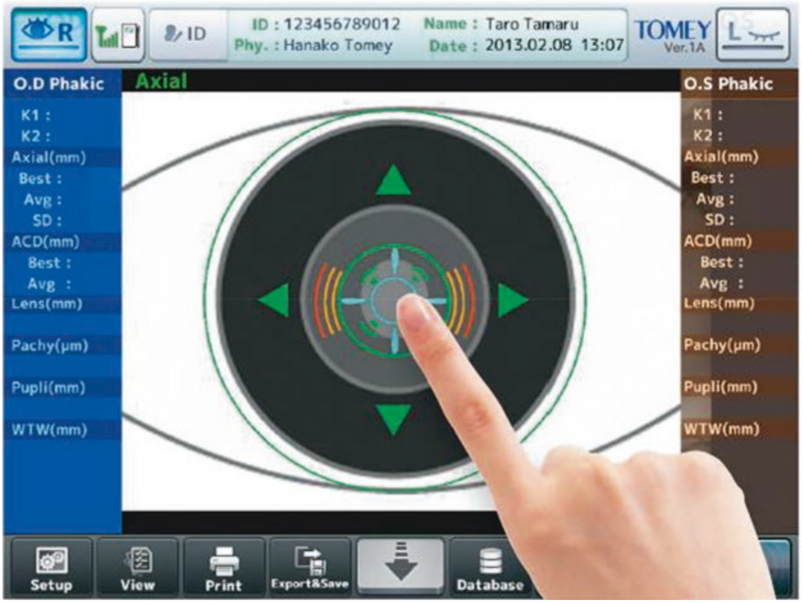

Fig. 21.2 Touch alignment, easy operation. http://vimeo.com/259629303?width=640&height=480

Fig. 21.3 Results of cataract eye with long axis length

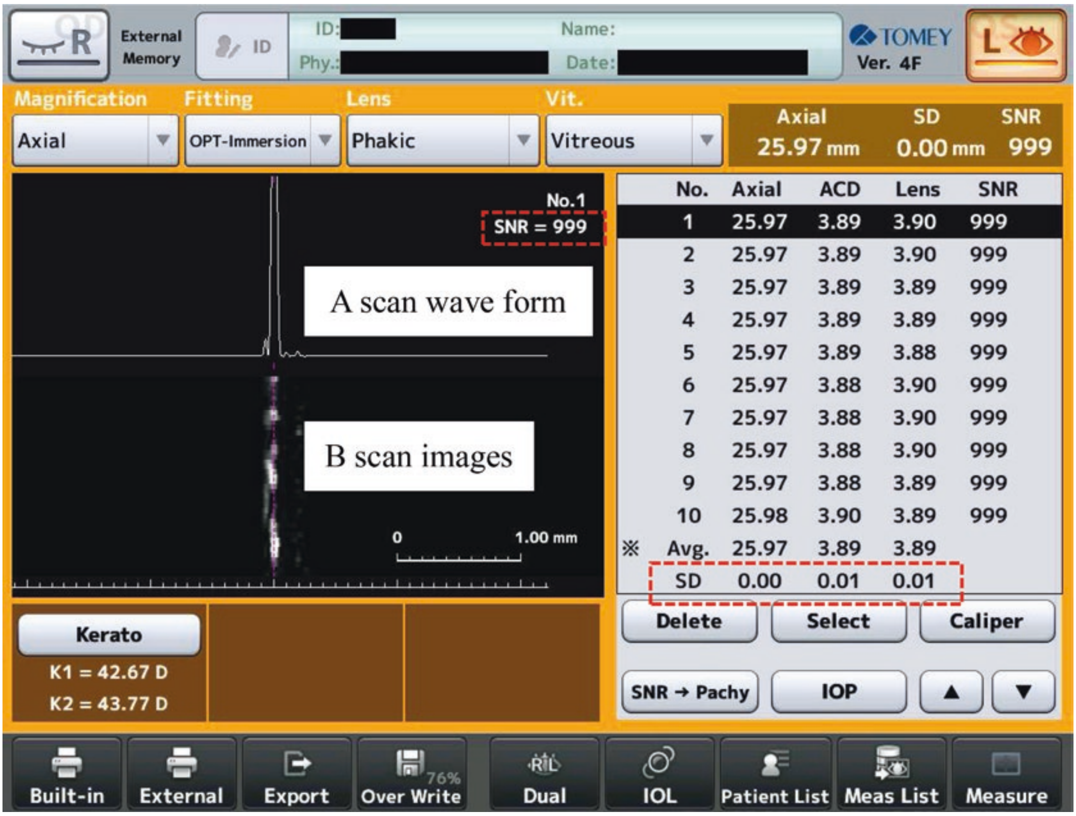

Fig. 21.4 Measurement result of normal eye

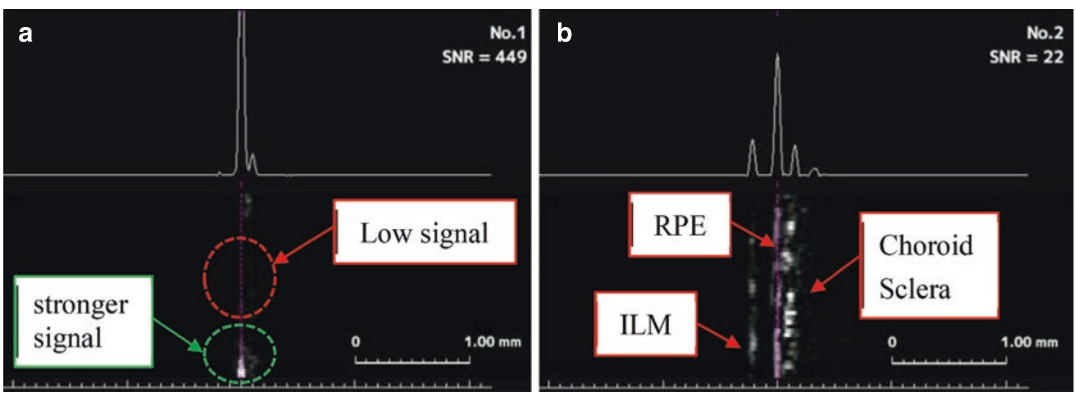

Fig. 21.5 Wave forms and B-scan images on retina of cataract eyes. (**a**) Lens central opacity. (**b**) Multi-peaks wave form

detected. High success rate is achieved by these techniques in combination.

In the case of dense cataract with low SNR, multi-peaks retinal waveforms may appear as Fig. 21.5b shows. OA-2000 detects retinal pigment epithelium (RPE) automatically by an original algorithm based on signal appearance ratio and peak analysis results. It is recommended to judge it comprehensively including the results of other examinations, when it is suspected if the

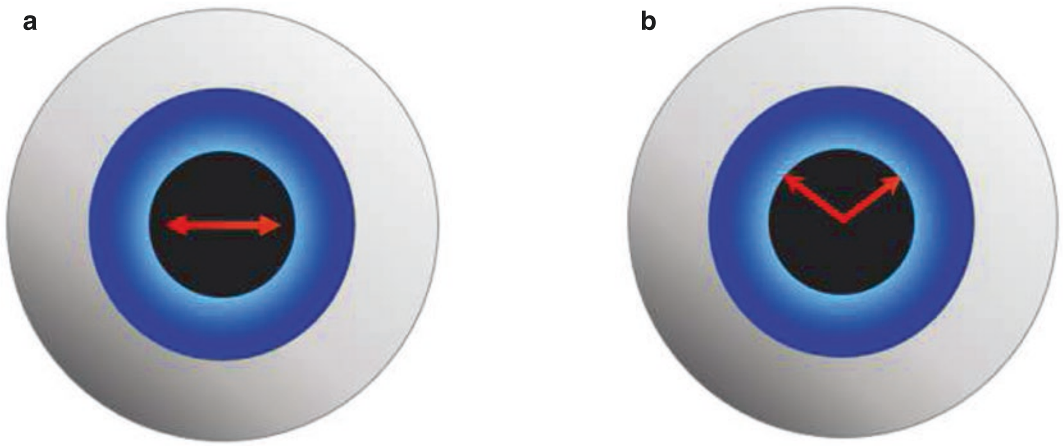

Fig. 21.6 Scanning methods on OA-2000. (**a**) Horizontal scan. (**b**) Vertical scan

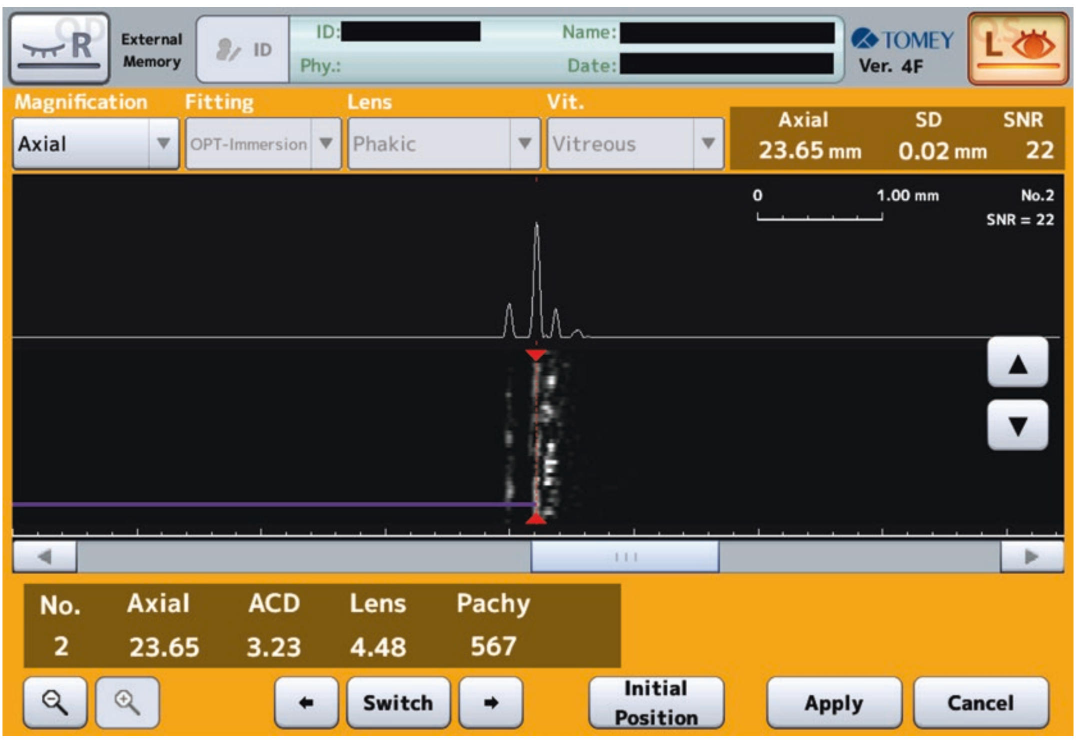

Fig. 21.7 Caliper function

detected retinal peak is correct or not, for example, miss-detecting epiretinal membrane as RPE. Caliper function (Fig. 21.7) allows operators to select RPE position manually if the auto-detected RPE is not correct.

For converting optical path lengths (OPLs) to geometrical distances, an original conversion formula was established by clinical dataset of ultrasound biometer and OA-1000, how to be performed based on the way by Haigis [4, 5]. OPLs of OA-2000 are in good agreement with OA-1000, which is the previous model; OA-2000 also uses the same conversion formula.

Clinical Cases

Clinical cases of cataract eyes are introduced in Fig. 21.8.

OA-2000 includes the function of wireless connection with ultrasound biometer AL-4000 (Fig. 21.9). It is useful when measurement is difficult by an optical biometer due to subject eyes conditions. The measurement results of AL-4000 can be transferred to OA-2000, and it can be used for IOL calculation on OA-2000.

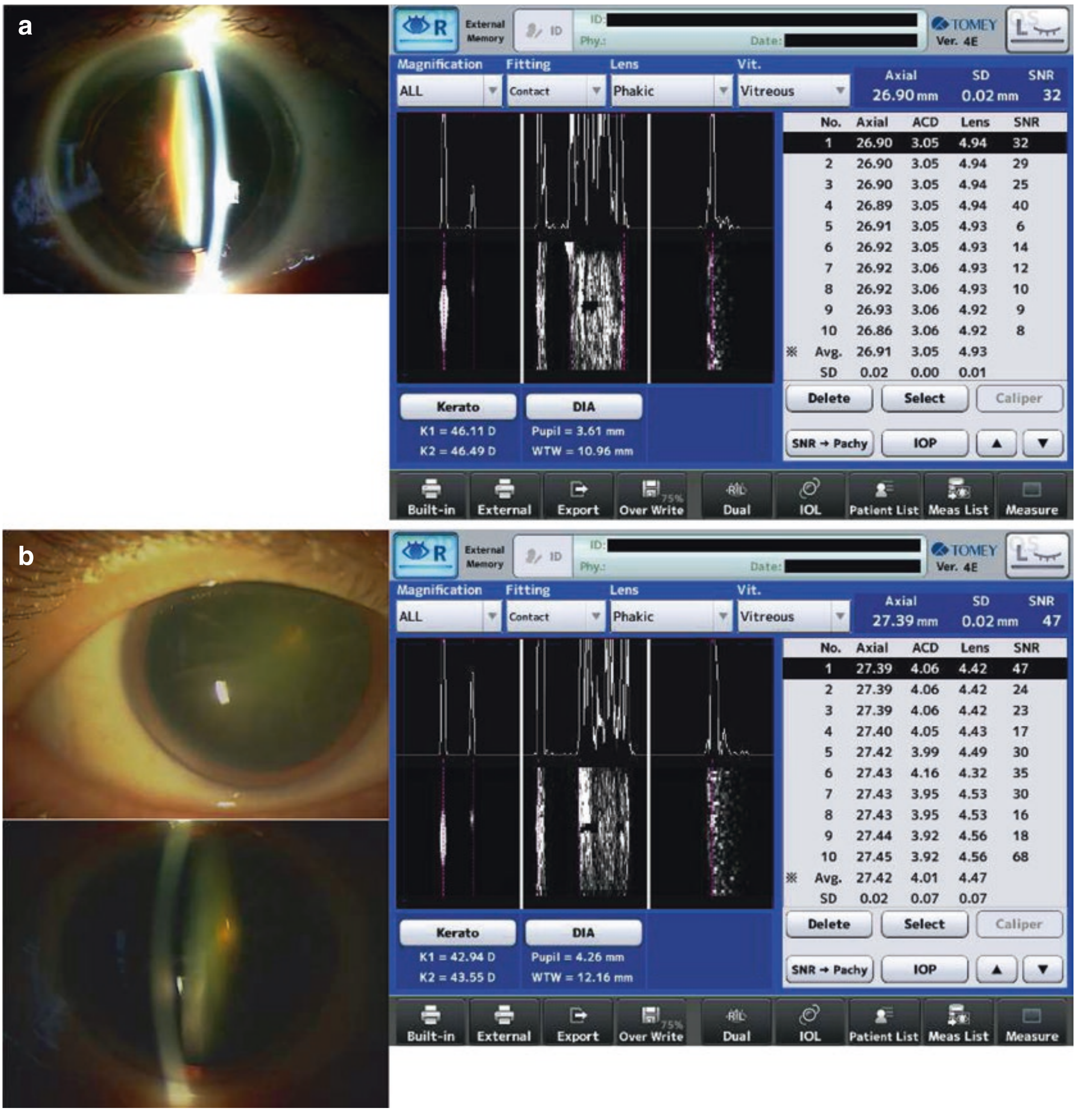

Fig. 21.8 Clinical cases of cataract eyes, Provided by Dr. Hitoshi Tabuchi, Chief director of Department of Ophthalmology, Tsukazaki Hospital. (**a**) Hypermature cataract eye. The nuclear sclerosis is Emery class V. SDs for axial length, ACD, and lens show small numbers even with relatively low SNRs; measurement result is stable. (**b**) Cortex and posterior subcapsular cataract eye. The nuclear sclerosis is Emery class III. SDs for axial length, ACD, and lens show small numbers even with relatively low SNRs; measurement result is stable.. (**c**) Cortex and posterior subcapsular cataract eye. The nuclear sclerosis is Emery class II-III. The retinal signal is very low because the opacity of the cortex and the posterior subcapsular is strong. However, SDs are small enough and the measurement result is stable

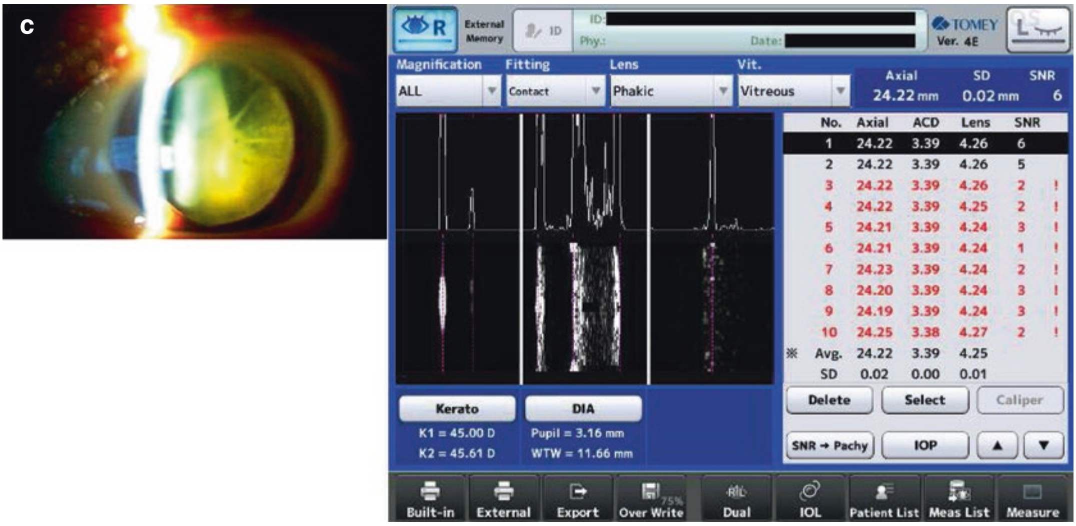

Fig. 21.8 (continued)

Fig. 21.9 Ultrasound biometer AL-4000

Measurement of Corneal Radius of Curvature and Topography

OA-2000 employs a Placido disc for measuring corneal radii and topography, which has been proven being an accurate measurement method and used for many years [6]. The Placido-based topography can capture image in a single shot; therefore, it is hard to be affected by eye motion, when performed at the same time as the axial length measurement. Figure 21.10 shows examples of comparison of topography map between TMS-4N and OA-2000 for same eyes. The measurement range of OA-2000 is 5.5 mm which is narrower than TMS-4N. However, it is enough for evaluating visual function, and they have good consistency in that range.

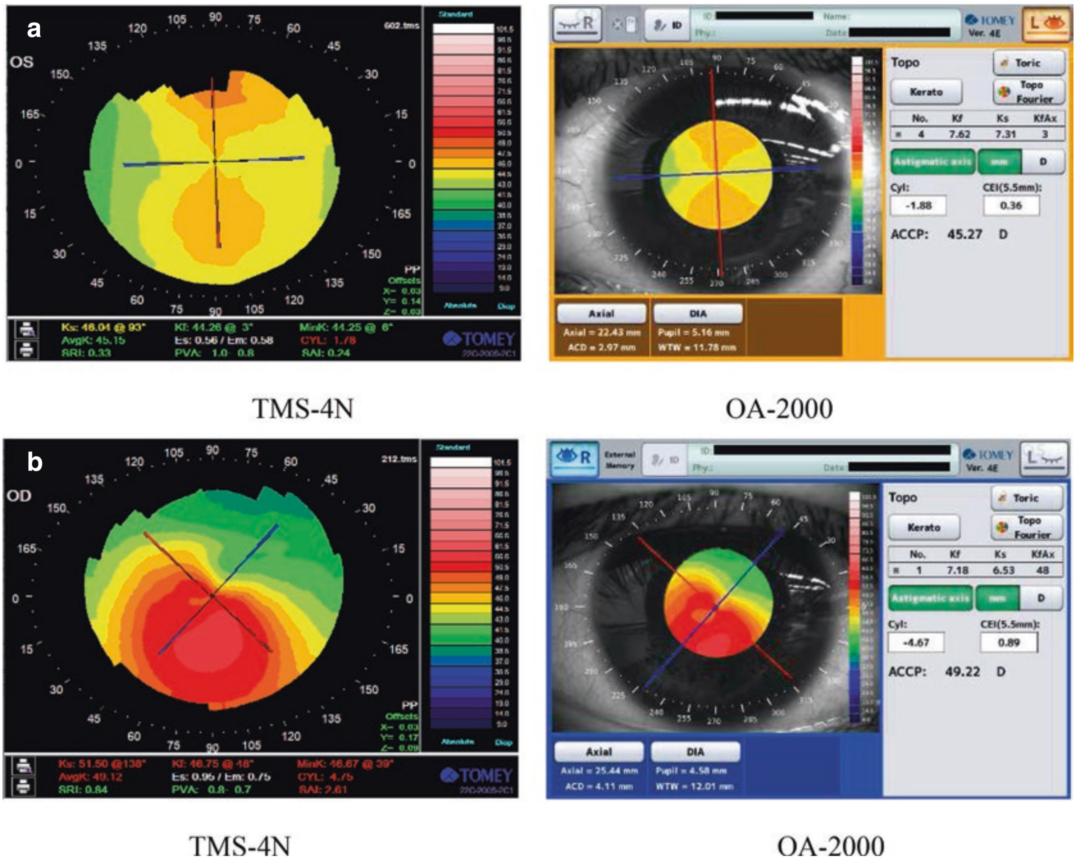

Fig. 21.10 Comparison between TMS-4N and OA-2000 on topography. (**a**) Topography of with-the-rule astigmatism eye. (**b**) Topography of keratoconus eye

Important Indices of Cornea for Cataract Surgery

OA-2000 provides not only the corneal radius of curvature results but also important indices of KAI (Kerato-Asymmetry Index) and KRI (Kerato-Regularity Index) (Fig. 21.11). These indices are ranked with A (Low)/B (Slightly high)/C (High) which show possibility to be irregular corneal astigmatism. When KAI shows high value in B or C, the eye is suspected to be a deformed cornea such as in keratoconus. When KRI shows high value, the eye is suspected to be a corneal transplant or with CL-induced problems, etc. It can call to attention checking the topographic maps so that doctors can prevent postoperative troubles. In the case that these values are high, there is higher risk of insufficient visual recovery and it should be carefully considered to choose multifocal IOLs.

CEI (Corneal Eccentricity Index) is shown in the topographic screen (Fig. 21.12). When CEI indicates positive number, the corneal shape is prolate which is normal eye. On the other hand, when CEI indicates negative number, the corneal shape is oblate which can be observed in typical post-LASIK eyes. By checking this value, even in the case that the surgical history is unknown, doctors can realize the possibility being post-LASIK eye and adopt post-LASIK IOL formula so that they can avoid refractive surprise after surgery.

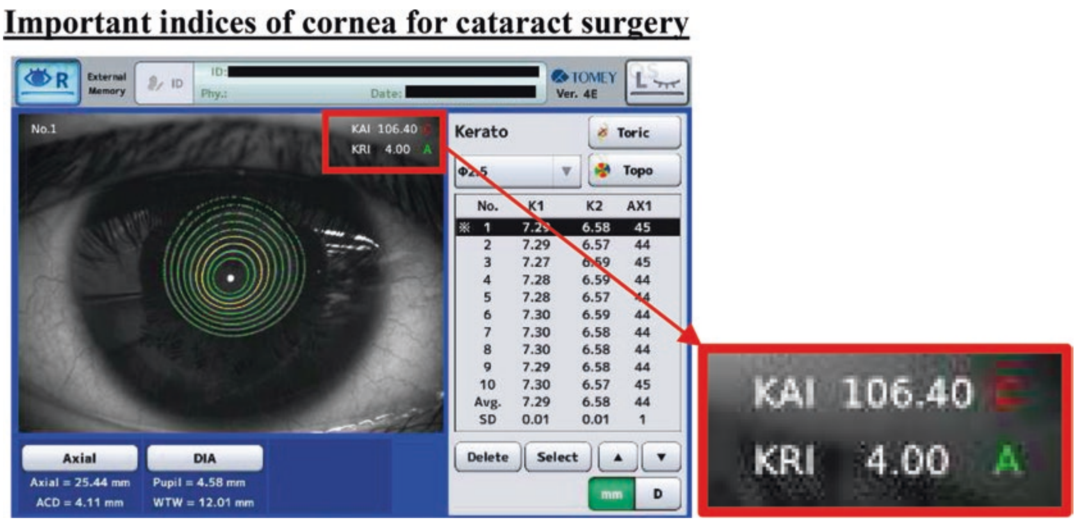

Fig. 21.11 Kerato-Asymmetry Index (KAI) and Kerato-Regularity Index (KRI)

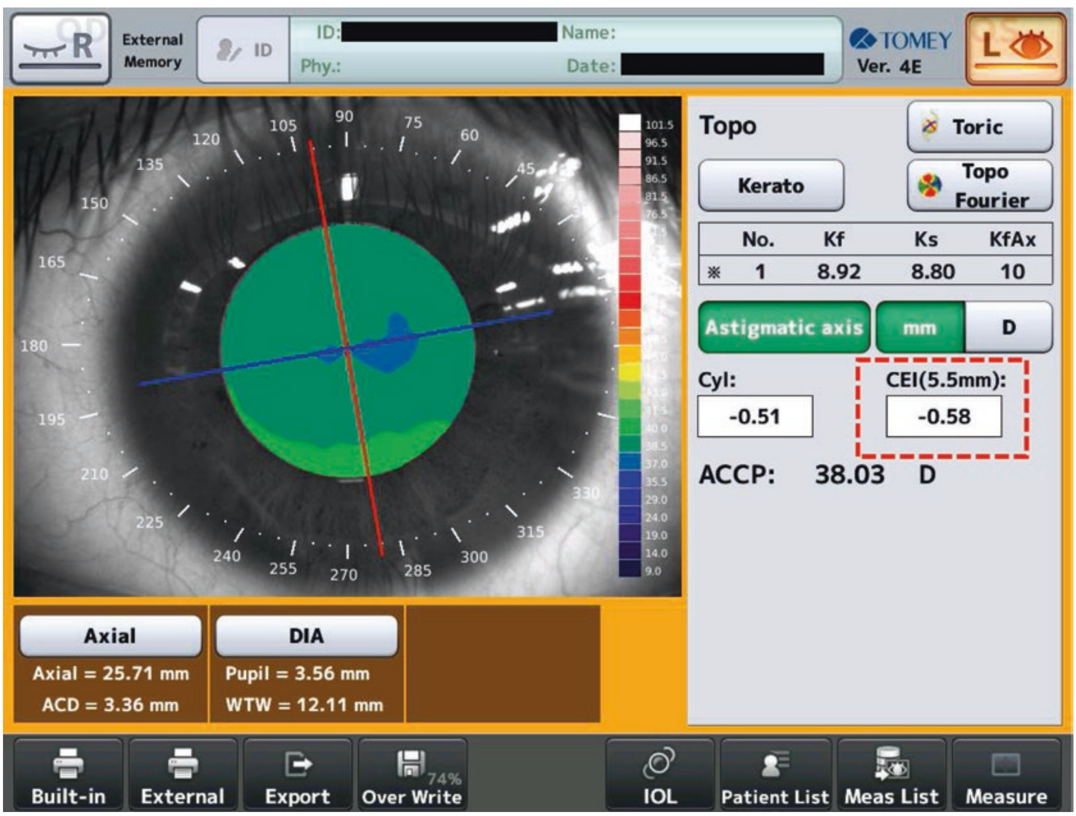

Fig. 21.12 Corneal Eccentricity Index (CEI) on post-LASIK eye

IOL Calculation and Toric Calculation

OA-2000 includes different kinds of IOL formulae, which are standard IOL formulae, toric IOL formulae, and post-Lasik IOL formulae (Table 21.1 and Fig. 21.13). In addition, function for optimization of IOL constants is included in OA-2000 and it can support to calculate personal lens constant for each surgeon (Fig. 21.14).

Toric planning function to support with axis registration is available (Fig. 21.15). It allows doctors to mark the target axis based on the reference axis of iris pattern or conjunctival blood vessels.

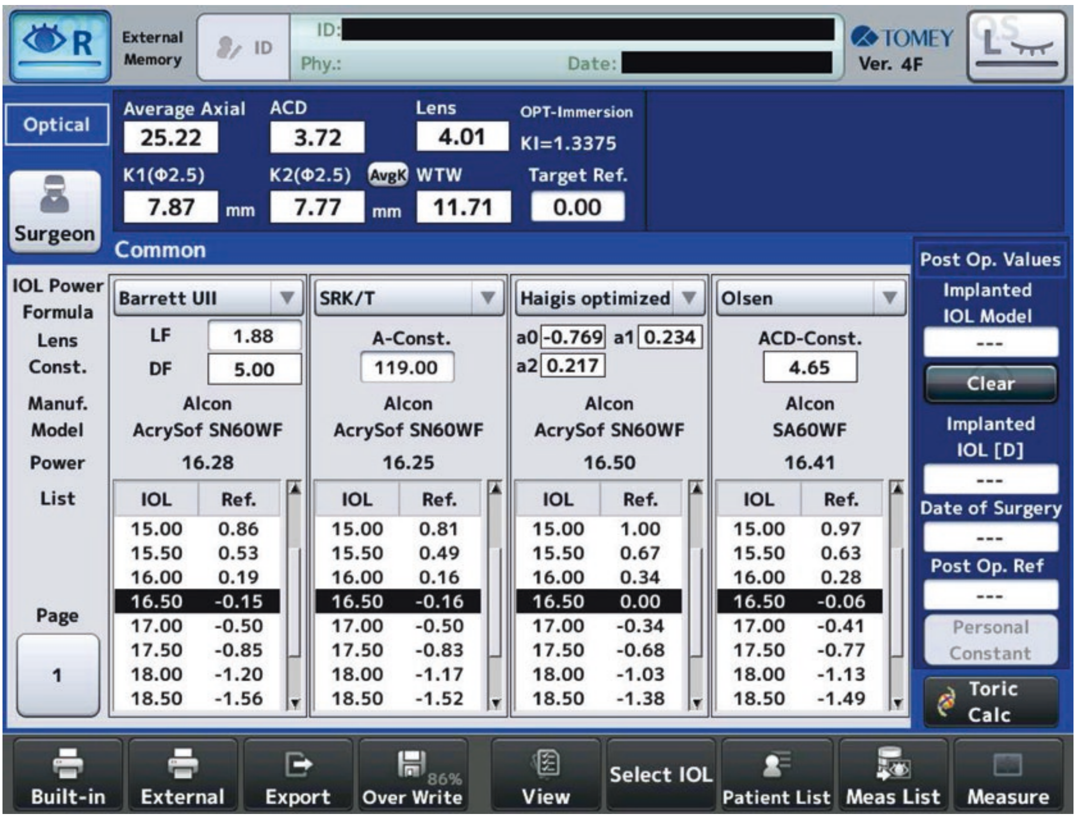

Fig. 21.13 IOL calculation screen

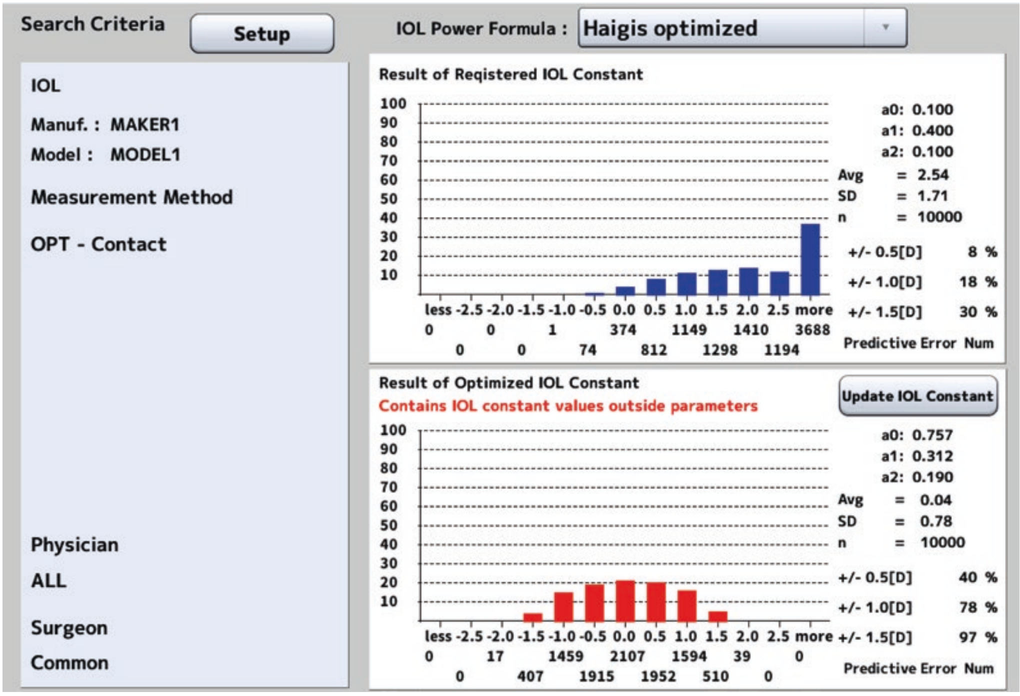

Fig. 21.14 Optimization of IOL constants

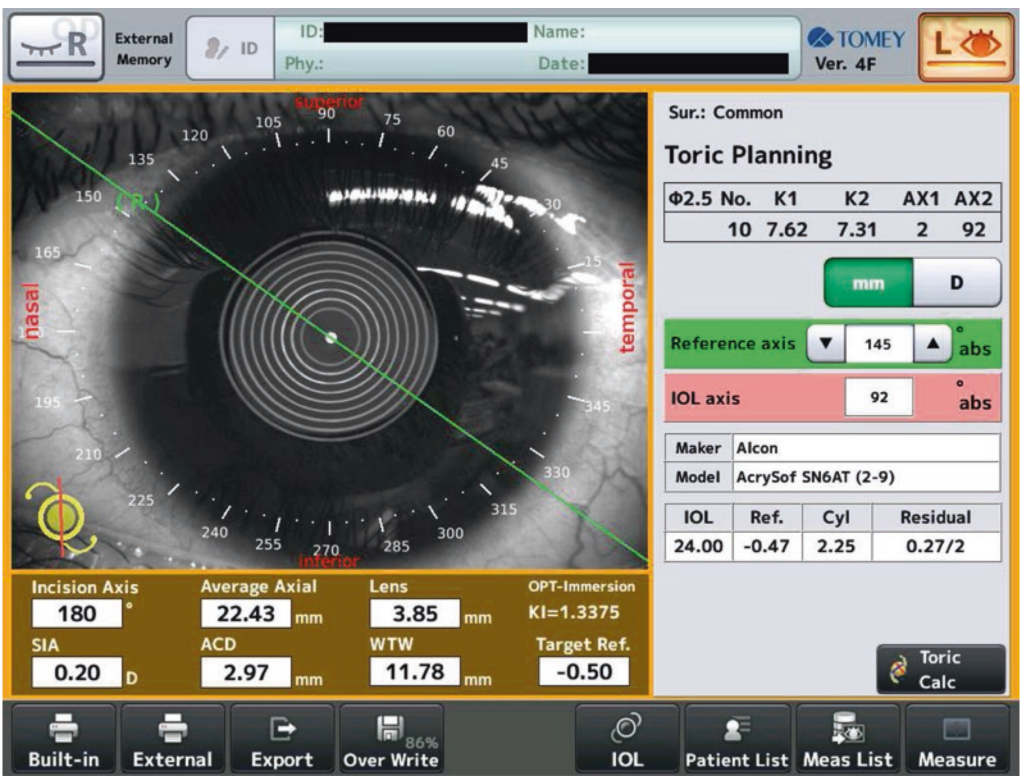

Fig. 21.15 Toric Planning screen

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