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Optical Biometer

Tips for OA-2000

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TOMEY

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TOMEY

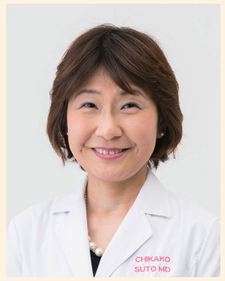
Introduction

A major turning point in axial length measurement for calculation of intraocular lens power is the shift from the ultrasound method to the optical method namely from “sound” to “light,” since medical service fees for this have been approved. Recently, there is a trend involving a shift from the time domain method to the Fourier domain method even within the optical method and the Optical Biometer OA-2000, released in 2014 which adopted the Fourier domain method.

The OA-2000 features high-speed, deep-reaching and highly-sensitive measurements. Measurement is taken almost automatically and a reduction in measurement time will reduce stress on patients. Highly-sensitive measurement by the Fourier domain method also allows us to measure axial length in cases that were difficult to measure by the time domain method.

I heard that users are sometimes at a loss to find the correct measurement method or when checking measured values because measurement accuracy has improved and the number of available measurement items has increased. So I designed this booklet to cover the characteristics of axial length measurement in the optical method and tips and precautions for the use of the OA-2000. I do hope you will use the OA-2000 effectively.

PROFILE



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1988 – Graduated from Tokyo Women’s Medical University School of Medicine
1992 – Completed master course of Tokyo Women’s Medical University School of Medicine and obtained a doctorate degree; assistant of ophthalmology at Diabetes Center, Tokyo Women’s Medical University School of Medicine
2004 – Assistant Professor at Department of Ophthalmology, Tokyo Women’s Medical University School of Medicine
2006 – Research fellow at Cole Eye Institute, Cleveland Clinic in USA
2007 – Assistant Professor at Department of Ophthalmology, Tokyo Women’s Medical University Schoolof Medicine (reinstatement), and also director of Department of Ophthalmology at Saiseikai Kurihashi Hospital
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Professor of Ophthalmology at Tokyo Women's Medical University Medical Center East
To present

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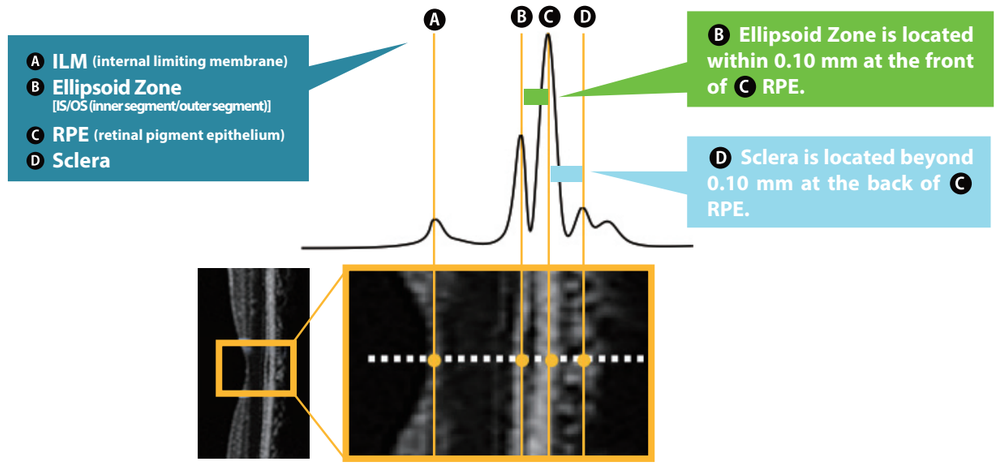
Tip 01

Characteristics of axial length measurement in Fourier domain method

The OA-2000 can detect signals in tomographic images of a retina through improving the sensitivity using the Fourier domain method.



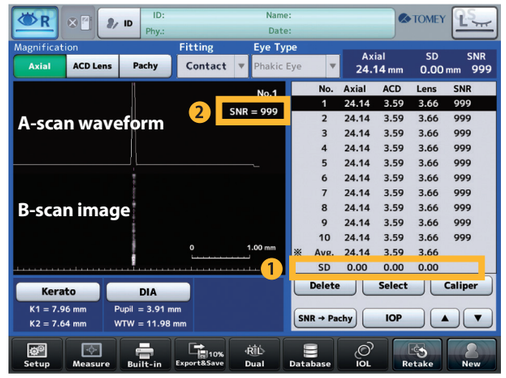
The order of waveform signals, from the strongest, is **C RPE > B Ellipsoid Zone > D Sclera > A ILM.** This is because the ILM signal is not often output and only the Ellipsoid Zone, RPE and sclera signals are detected in many cases of actual measurements. In addition, depending on the retina conditions, the Ellipsoid Zone and sclera signals are not output, or the Ellipsoid Zone signal is slightly stronger than RPE.

Example of axial length measurement of normal eye

This is the viewer screen after measurement. A-scan waveform (upper section) and B-scan image (lower section) are displayed in the results of axial length measurement. The high-brightness area in the B-scan image is called A-scan waveform here.

If no abnormality is found at the ocular fundus, the values will be as shown below in many cases.

1. **SD (standard deviation) that shows variations in axial length is 0.00.**
2. **SNR (signal-noise ratio) is as high as 999.**



What is “SNR (signal-noise ratio)” ?

This is also called the “SN ratio.” This is the signal-to-noise ratio, namely, the ratio of the signal peak against the measurement noise. The higher this value is, the higher the waveform becomes. It is said that the value of a reliable waveform should be 3 or more and, in most cases, measurements can be adopted as they are, if SNR is 3 or more and there is no significant variation between measurements. However, we need to be careful because SNR tends to be small depending on the progress of cataracts or the presence of ocular fundus diseases and, in rare cases, the internal limiting membrane or sclera is captured instead of the retinal pigment epithelium even when SNR is high enough.

When values vary depending on the condition of the patient's eye, you need to judge the measurement comprehensively including the results of other examinations.

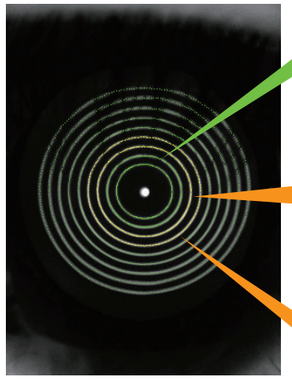
Tip 02

Keratometry and topography

The basic information of keratometry and topography in OA-2000 is summarized here.

Keratometry

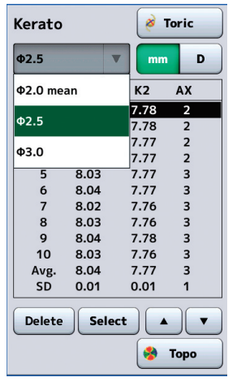
The OA-2000 is designed to perform a keratometry measurement using the mire ring method that projects concentric circular light onto the corneal surface. The radius of corneal curvature of steepest meridian (K2) and that of flattest meridian (K1) are calculated according to the projected mire rings. There are 3 measurement positions on the cornea depending on the application.



Keratometry value at 2.0 mm of diameter
(2nd ring from the inside / Green)
The mean of corneal curvature radius at a point nearer to the center is displayed for reference.

Keratometry value at 2.5 mm of diameter
(3rd ring from the inside / Yellow, inside)
Keratometry value when set to "OPT-Immersion fitting mode"

Keratometry value at 3.0 mm of diameter
(4th ring from the inside / Yellow, outside)
Keratometry value for "Contact fitting mode" is displayed for reference.



▲Choose settings from the pull-down menu.

KAI/KRI (Irregular corneal astigmatism index)

When keratometry measurement is conducted, "KAI" and "KRI" (Irregular corneal astigmatism index) appear in the upper right to the mire rings.

●What is KAI (Kerato-asymmetry Index) ?

This is a value to indicate the **asymmetry of the cornea**. The value increases if the cornea is not a normal oval such as when a part of the cornea protrudes. A typical case is an eye with a deformed cornea such as in keratoconus.

●What is KRI (Kerato-regularity Index) ?

This is a value to indicate the **regularity / irregularity of the cornea**. This value increases when the corneal surface is not smooth. A typical case is an eye with a corneal transplant or CL-induced problems.

Both KAI and KRI are the indexes that show 3 levels of irregular astigmatism as A, B and C. In the case of level B or C, it is recommended to inspect the corneal shape in detail by checking the color code map.

A Possibility of irregular corneal astigmatism is **Low**

B Possibility of irregular corneal astigmatism is **Slightly high**

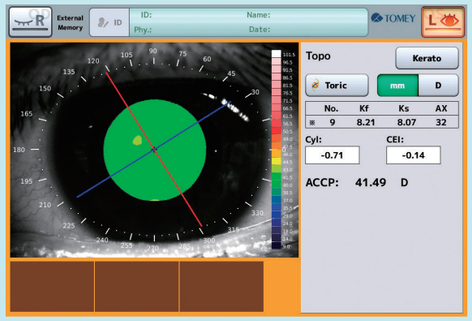
C Possibility of irregular corneal astigmatism is **High**

Topography

The OA-2000 is designed to analyze 9 mire rings projected on the cornea and display the distribution of the radius of corneal curvature within a diameter of 5.5 mm as a color code map. Touch the Topo button on the viewer screen to check the map.

Example: Normal eye without astigmatism

The map is shown in a similar tonal color.

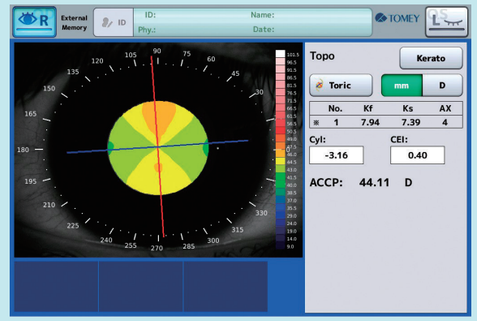


●Point

Symmetry condition of a normal eye is generally favorable and the map is shown in similar tonal color.

Example: Corneal astigmatism

Warm-color pattern appears in the vertical direction in the case of with-the-rule astigmatism (WTR).

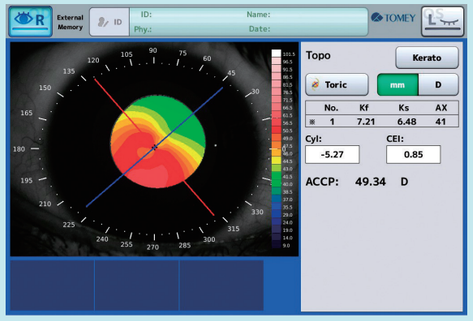


●Point

This is an example of a strong corneal astigmatism eye of which corneal astigmatism (Cyl) is -3.16D and astigmatism axis is 4°. The steepest meridian (red line) in the vertical direction indicates WTR and in the horizontal direction indicates against-the-rule astigmatism (ATR).

Example: Keratoconus

Warm-color pattern that shows protrusion of corneal shape appears.

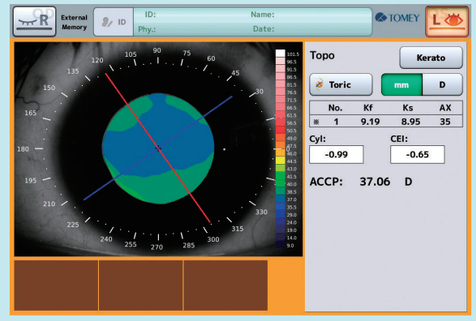


●Point

In a map pattern like this, KAI after keratometry measurement shows a high value. Special attention is required for IOL power calculation.

Example: After LASIK surgery

Cold-color pattern appears in the center of the cornea.



●Point

It can be seen that the corneal surface has been flattened by excimer laser. It can be determined immediately whether or not LASIK surgery was performed in the past by checking the topography before cataract surgery. Special attention is required for IOL power calculation.

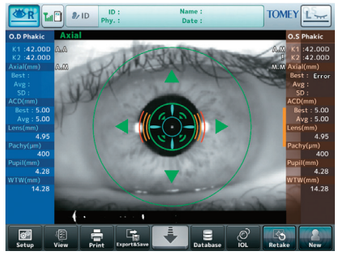
Tip 03

Key points for measurement

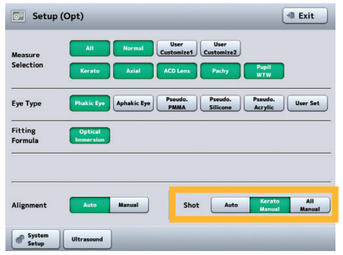
The key points to perform measurement correctly are summarized below. Contents introduced on this page are important not only for axial length measurement but also for keratometry measurement and topography measurement.

Make full use of automatic functions

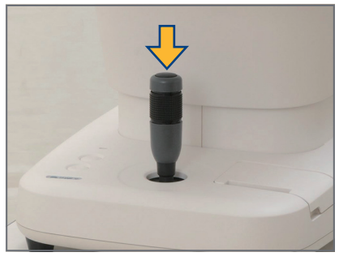
The OA-2000 is designed to perform auto alignment and auto shot by operating the touch panel. You can also execute "manual measurement" in order to allow the patient to blink adequately and fix their sight.



Alignment is completed when the blue mark appears.



You need to input settings on the "Setup" screen to take measurements manually. Touch the "Setup" button on the lower left corner of the measurement screen to open the Setup screen. It is recommended to take measurements manually when the patient's sight is not fixed adequately.



Press the measurement button on the joystick to start measurement manually.

Ensure patient's sight is fixed

Unstable sight may cause faulty measurements. This influences more than the axial length. Because the OA-2000 performs keratometry and topography measurements using the mire ring method, ring images are projected, considering the corneal vertex as the center. If the patient's sight is not fixed, mire rings are not projected around the corneal center, resulting in incorrect measurement results.

Example: Measurement on the same eye

Mire rings are projected around the corneal center.

▲ The sight is fixed adequately and the astigmatic axis indicates 158 degrees.

Mire rings are projected on the lower section of the cornea.

▲ The sight is not fixed adequately and the astigmatic axis indicates 171 degrees.

HELP & SUPPORT

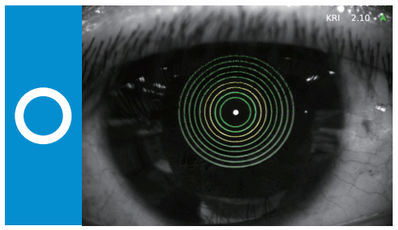
When it is difficult to guide the sight

If it is difficult for the patient to fix their sight, guide either eye and adjust the line of sight.

① **When attempting to capture an image on a blind eye with both eyes open, close the other eye with a fingertip or sticker.**
② **If the eye that can see causes confusion, cover it with a piece of gauze or the like.**

Indicate the patient to blink sufficiently

It is important to avoid deformation of mire rings in order to correctly measure Keratometry values needed for calculating IOL power and also to take topography measurements correctly. Start measurements while the corneal surface is adequately covered with a tear film.



▲ Mire rings image are deformed and measurement needs to be taken again.

HELP & SUPPORT

When the tear film is insufficient

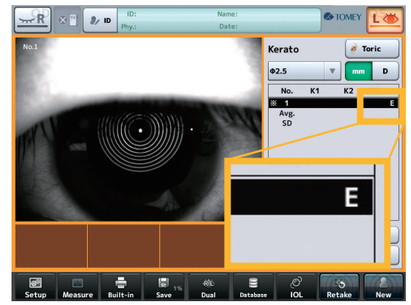
First, ask the patient to blink.

① **When the patient's eye dries out, apply artificial lacrimal fluid to the eye. In this case, it is recommended to capture images as quickly as possible.**
② **When the tear fluid is oily, apply artificial lacrimal fluid and then ask the patient to keep their eyes open for a while.**
Then, capture an image when debris on the surface of the eye is reduced and the eye is ready for measurement.

Have the patient open their eyes widely

When an eye is not open sufficiently, it not only takes time for alignment (focusing) before measurement, but measurement cannot be performed because adequate measurement points to calculate the radius of corneal curvature are not obtained. Help the patient open their eyes if they have difficulty.

If the eye is not open sufficiently, keratometry measurement cannot be taken and an error mark "E" appears.

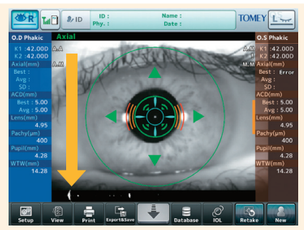


HELP & SUPPORT

To prevent insufficient opening of eyes

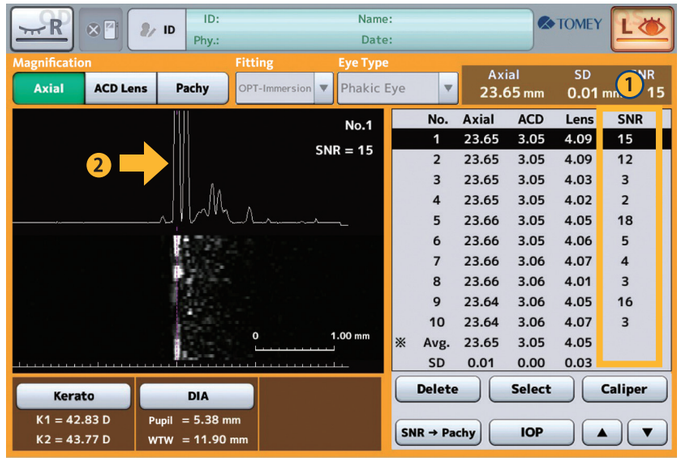
Opening of the eyes largely affects measurement results of ① keratometry value / topography value, ⑥ pupil (pupil diameter) and ⑦ white to white. Correct measurement can be taken if you help patients that have difficulty opening their eyes widely by themselves. The OA-2000 performs measurements in the following order.

① Keratometry value / topography value > ② Axial > ③ ACD > ④ Lens > ⑤ Pachy > ⑥ Pupil > ⑦ WTW



▲ Measurements are listed in order on the measurement screen.

Tip 04 “Multi-peak” axial length measurement



Features of the Fourier domain method enable measurement even in some cases of very opaque cataracts. In this case, because the amount of light that reaches the retina is reduced, 1 SNR tends to be small and 2 it seems as if there are multiple peaks (= multi-peak) in the waveform in some cases.

When there is a multi-peak waveform

Because measurement is taken at high resolution, waveforms are displayed as if there are many peaks. However, the distance between peaks does not influence the calculation of IOL power in most cases. If measurement results do not vary (SD value is low), it is assumed that there is no problem adopting these measurement results. When making corrections, adjust the caliper line to the highest peak.

Note

If the distance between peaks is 0.4 mm or more, check that the waveform conforms to the data of the ocular fundus and caliper the distance based on the result.

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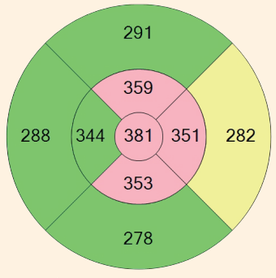
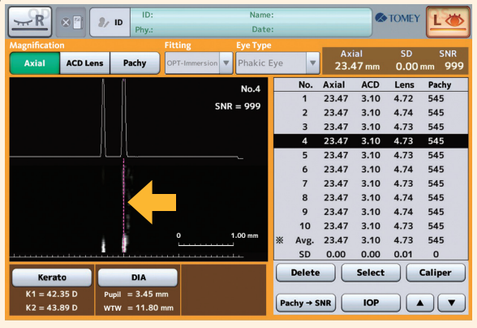
Confirming condition of ocular fundus

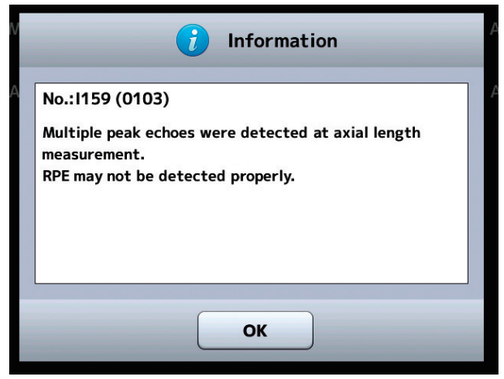


▲ ILM-RPE thickness (μm)



This is a case in which macular pucker and a double peak was detected. When the OCT data of ocular fundus was checked, the thickness of the fovea on the retina was 381 μm (left illustration). When the waveform of the OA-2000 was checked using the scale on the image, the distance between peaks was about 0.4 mm. So, it was found that the first peak captured the macular pucker and the second peak captured RPE (right figure). In this case, because the detection line on the image correctly captured the rear RPE, calipering was not required.

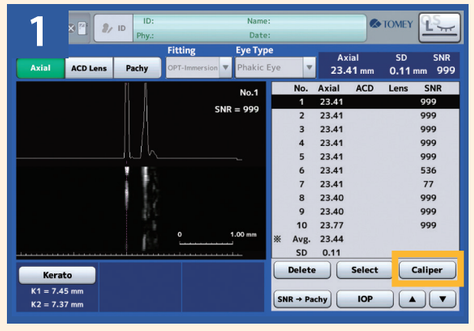
When a double peak or multi-peak is found in the measurement waveform, the message shown on the right may appear.



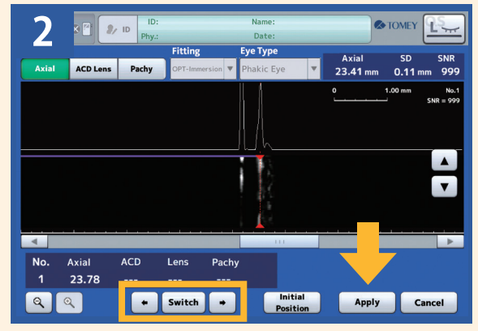
HELP & SUPPORT

Caliper function for axial length measurement

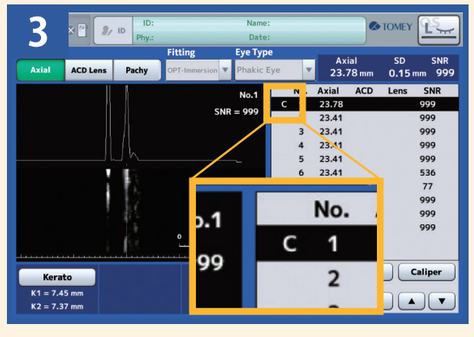
Use the caliper function if the detection line of the retina needs to be corrected manually.



Touch the “Caliper” button [Caliper] to open the caliper screen.



Move the retina detection line with the arrow buttons [←] [Switch] [→] and then touch the “Apply” button [Apply].



A “C” mark appears on the calipered data. Once the value is defined, “C” does not disappear even if the line is returned to the initial position.

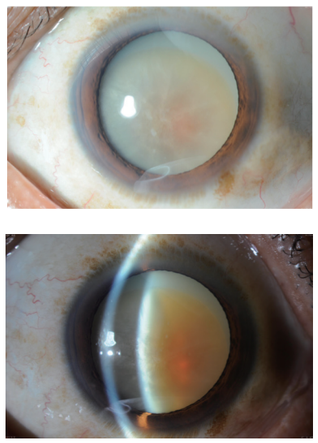
* Data source: ©Yada Ganka Iin (Izunokuni City)

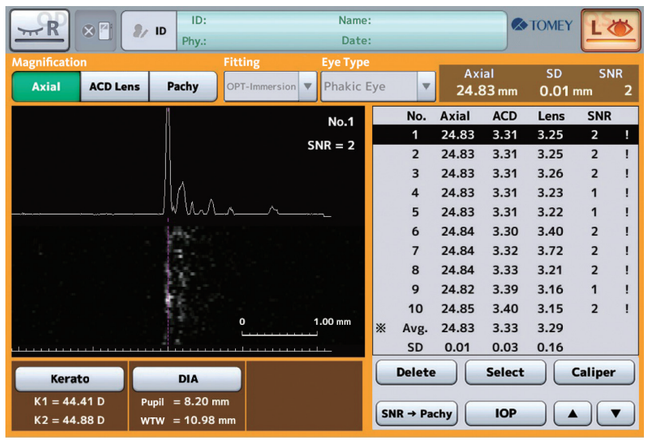
Tip 05

Measurable cases

The following cases were able to be measured with the OA-2000.

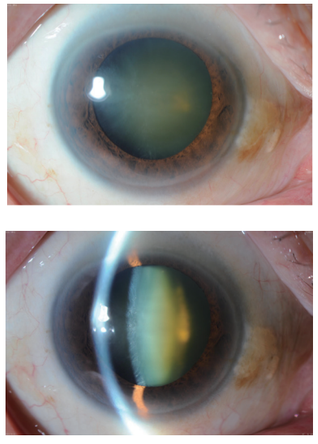
Morgagnian cataract

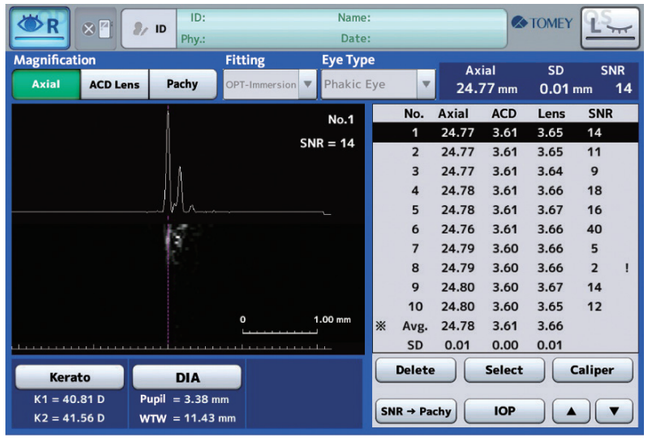




A case of Morgagnian cataract. The nuclear sclerosis is Emery class IV or higher. Ocular vision before surgery was motus manus. SNR using the time domain method was 1.2 and measurement could not be taken.

Posterior subcapsular cataract



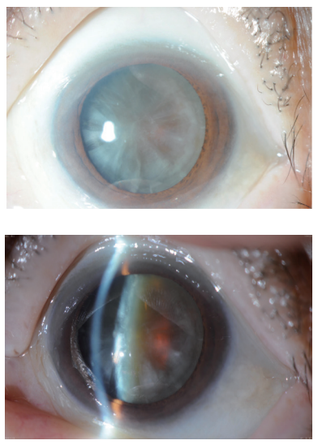


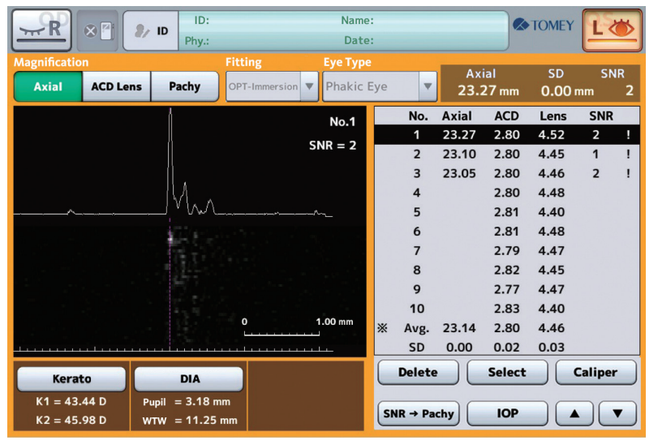
The nuclear sclerosis is a complication of Emery class III and sticky posterior subcapsular cataract of Crews class grade 4. Ocular vision before surgery was 0.08. SNR using the time domain method was 1.3 and measurement could not be taken.

Measurement success rate of posterior subcapsular cataract

The measurement success rate of posterior subcapsular cataract in the time domain method tends to lower according to the grade. However, OA-2000 (Fourier domain method) does not show differences in measurement success rates according to the grade.

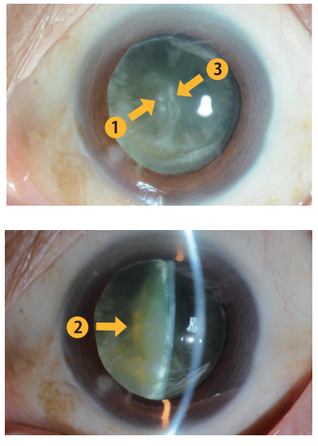
Nuclear sclerosis grade 4

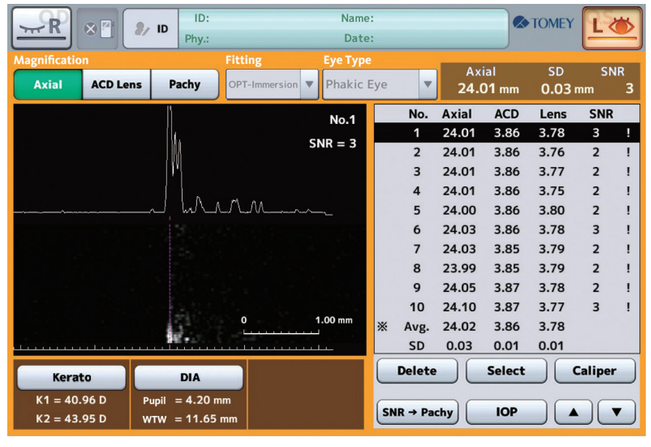




The nuclear sclerosis is Emery class IV. Ocular vision before surgery was 0.01. SNR using the time domain method was 1.8 and measurement could not be taken.

Opacity at center of crystalline lens





The nuclear sclerosis was Emery class II, but strong opacity exists at the center of the crystalline lens (1 anterior subcapsular cataract at 2 small points, 2 posterior subcapsular cataract of Crews class grade 3 and 3 strong cortical opacity at the center). Ocular vision before surgery was 0.02. SNR using the time domain method was 1.0 and measurement could not be taken.

Comparison of measurement success rate between Fourier domain method and time domain method

OA-2000 (Fourier domain method)	TD1 (Time domain method)
97.5%	92.0%

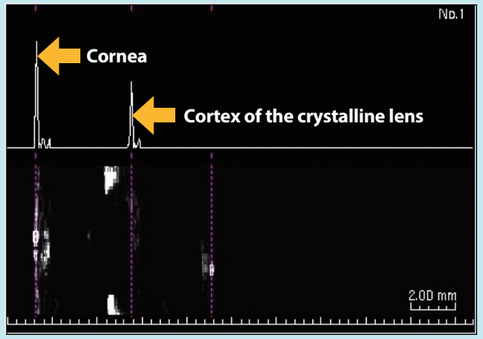
There is a significant difference ($p < 0.01$ Chi-squared test).

Tip 06 Anterior chamber depth (ACD)

The OA-2000 is designed to measure anterior chamber depth by scanning the crystalline lens with the measurement light and detecting signals reflected from the anterior and posterior surfaces of the crystalline lens. The lens thickness is also shown on the viewer screen.
In Ver. 1Y and later, the measurement algorithm of the anterior chamber depth (ACD) and crystalline lens thickness (LENS) was reviewed to improve the measurable case rate and reduce incorrect measurements. The detection sensitivity has been improved and the B-scan image of the anterior chamber can be displayed more clearly on the viewer screen after measurement.

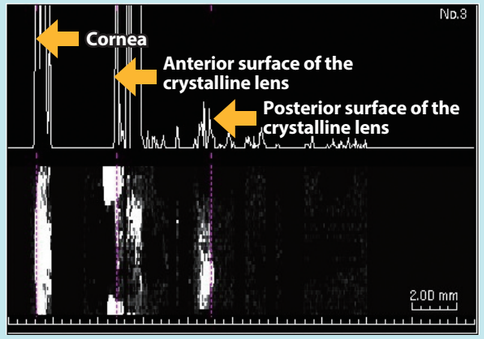
Example of display: Before upgrading

Because the image of the anterior surface of the crystalline lens was indistinct, the cortex was incorrectly detected.



Example of display: After upgrading

The image of the anterior surface of the crystalline lens became clear and larger waveforms are detected.



Note

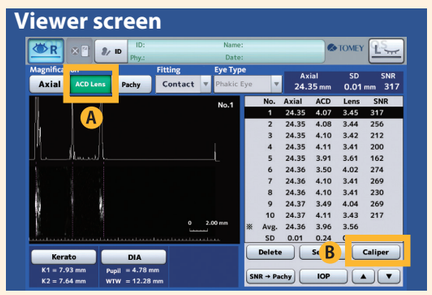
If you are using an older version (Ver.1X or before), it is recommended to upgrade to the latest version. **Contact your local distributor for upgrade.**

HELP & SUPPORT

Caliper function for ACD value

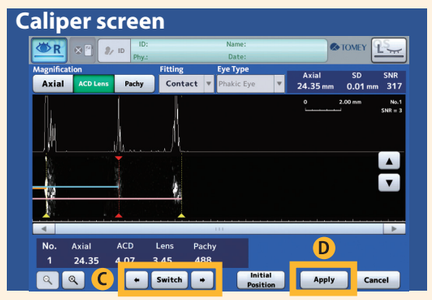
When the anterior chamber depth is unstable, check the detection position at the anterior surface of the crystalline lens and correct the position using the caliper function as needed. The lens thickness can be corrected on this screen.

Viewer screen



Touch the "ACD Lens" button (A) to open the ACD/Lens thickness viewer screen. Touch the "Caliper" button (B) to open the caliper screen.

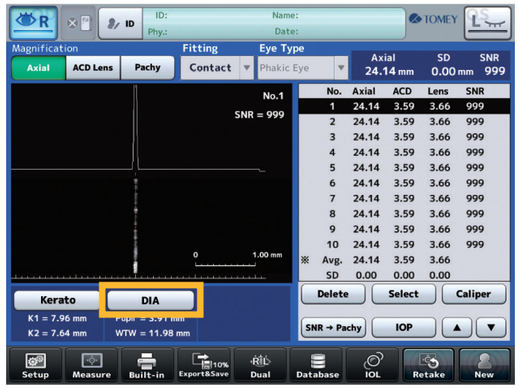
Caliper screen



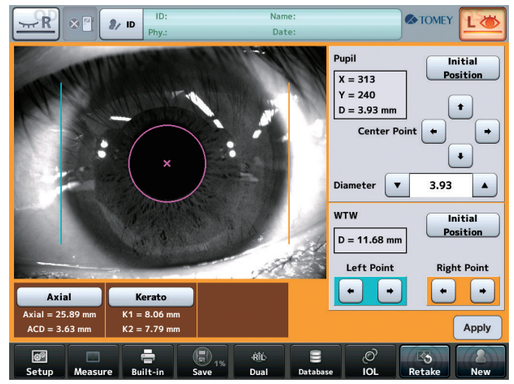
The lines to be corrected are displayed in red. Select the line to be corrected using the "Switch" button. Move the selected line using the arrow buttons (C) and then touch the "Apply" button (D). A "C" mark appears on the calipered data.

Tip 07 Corneal lateral diameter (White to White)

The corneal lateral diameter is used to determine the size of Phakic IOL etc.



Touch the "DIA (pupil diameter/white to white)" button DIA on the viewer screen to open the corneal lateral diameter screen.

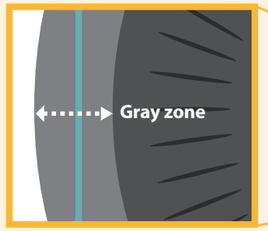


The resultant pupil diameter is also displayed together with the white to white. Check that the left measurement line (blue) and right measurement line (orange) on the photograph of the anterior chamber are situated in the correct position of the corneal ring.

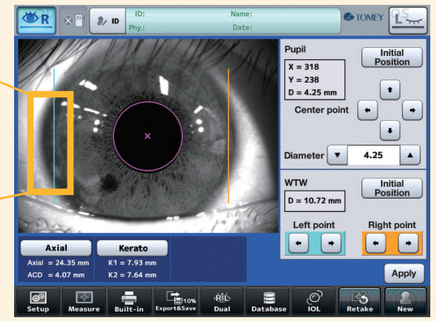
HELP & SUPPORT

Measurement of white to white

Check that the corneal lateral diameter is correctly measured and, if the measurement is offset, correct it using the caliper function.



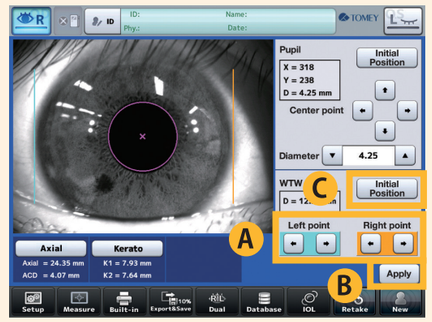
If the gray zone is wide when measuring the corneal lateral diameter, align the line with the center of the gray zone.



If the line is offset from the limbus, touch the "Left Point" or "Right Point" buttons (A) to manually correct the line position.

Touch the "Apply" button (B) to correct the value.

Touch the "Initial Position" button (C) to reset the line position to its original state.



Tip 08

IOL power calculation

The OA-2000 is designed to automatically start calculation and displays the result when all items required for IOL power calculation are set. 9 types of IOL power calculation formulae are available.

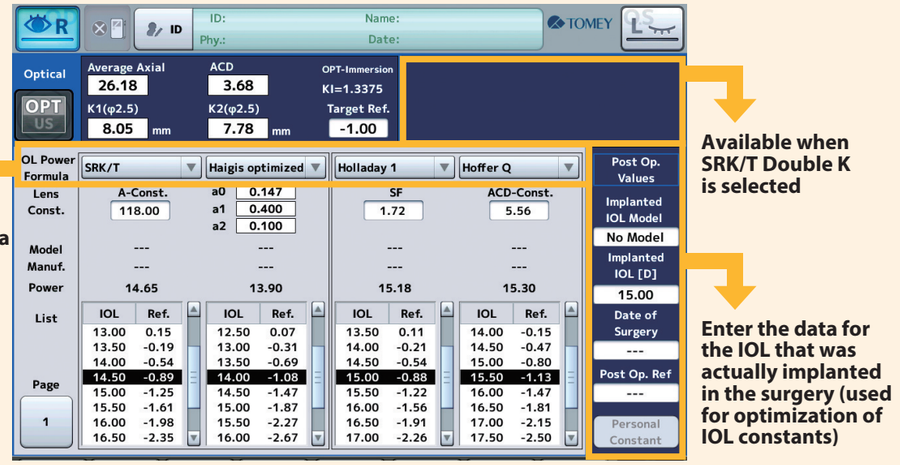
- **Haigis standard**
- **Haigis optimized**
- **Hoffer®Q**
- **Holladay 1**
- **SRK/T**
- **Shammas-PL**
- **SRK/T Double K**
- **OKULIX (optional)**
- **SRK SHOWA**

*New formulae will be installed in the near future.

It is recommended to optimize IOL constants in order to improve the accuracy of IOL power calculation.

HELP & SUPPORT

How to use IOL power calculation



Select a formula

Available when SRK/T Double K is selected

Enter the data for the IOL that was actually implanted in the surgery (used for optimization of IOL constants)

Note

There are 3 types (a0, a1 and a2) of IOL constants for the Haigis formula in addition to the A constant.

Haigis standard formula ..... Formula that converts only constant a0 which is unique to the IOL from the A constant in the instrument, while fixing the factor related to the anterior chamber depth (a1 = 0.4) and that related to the axial length (a2 = 0.1)

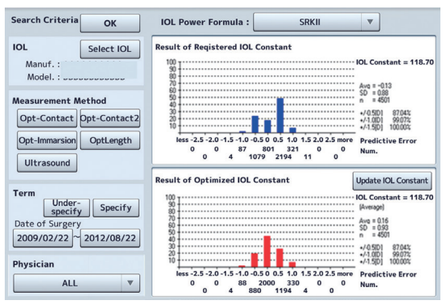
Haigis optimized formula .... Formula that optimizes and uses all 3 constants, a0, a1 and a2. Post-surgery data of 200 or more eyes need to be registered for optimization.

Optimization of IOL constants (statistical processing)

Statistical processing can be performed when 10 or more cases of post-surgery data are saved under the same conditions on the IOL power calculation screen.

Predictive errors when using the registered IOL constant are calculated and a histogram is displayed.

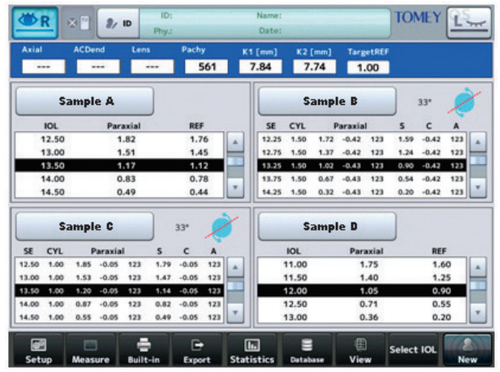
The optimized IOL constant can be updated based on the result of statistical processing.



Formulae for post LASIK eyes

The following formulae can be used for the IOL power calculation of post LASIK eyes.

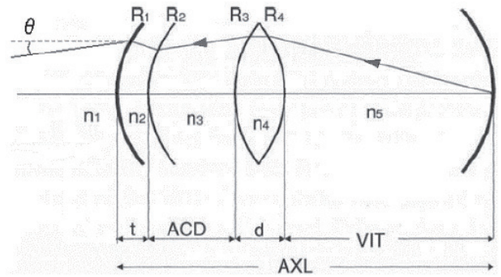
- **Shammas-PL**
- **SRK/T Double K**
- **OKULIX**



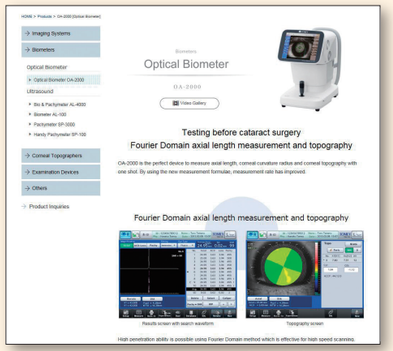
What is OKULIX ?

OKULIX is the IOL power calculation software used for the anterior segment OCT CASIA and TMS. This software uses a ray tracing method and is very effective for IOL power calculation for eyes after refractive surgery.

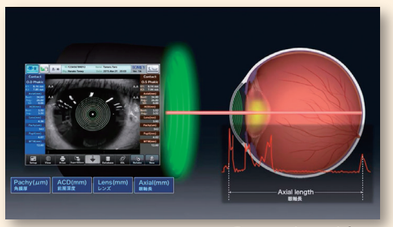
This software is designed to consider 4 refracting surfaces (Anterior / posterior surface of the cornea, anterior / posterior surface of the IOL) which traces the light ray at the position apart from the optical axis of the pupil (pupil radius /√2).



For more information, visit PRO+ website



Product information



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