

Operational Experience with the EM-3000™ Non-contact Specular Microscope

a report by

Shigeru Kinoshita, MD, PhD and Akiko Fukumoto, MD

Department of Ophthalmology, Kyoto Prefectural University of Medicine DOI: 10.17925/USOR.2007.03.00.11

A non-contact specular microscope makes no direct contact with the eye and is effective in capturing images easily, two features that are important for clinical applications. However, there are some disadvantages, such as a narrower capturing range and lower image quality compared with a contact-type specular microscope. It has also been found that errors can arise from the automatic analysis of captured images. However, the Tomey EM-3000™ non-contact specular microscope mostly solves these problems. As we have had the opportunity to use the EM-3000 in our clinic, it is our pleasure to introduce this new instrument.

Features

The EM-3000 is an 'all-in-one' specular microscope that includes an in-built program to automatically analyze images of corneal endothelial cells, thus allowing physicians to easily perform automatic analyses without the use of a personal computer (see *Figure 1*).

The primary advantages of the EM-3000 include ease of operation and rapid image capture. The 'one-touch' panel of the EM-3000 allows for quick and easy operation of the instrument simply by touching the screen. The 'autoalignment' and 'autoshot' functions instantly capture images when the center of the pupil shown on the screen is touched as the capturing head moves toward the eye to be examined. In addition, since the capturing head moves automatically, the patient can remain stable even when switching the eye to be captured from right to left, thus the EM-3000 provides increased comfort for the patient. As the capturing time is only 1.2 seconds, the patient does not need to stop blinking. Moreover, since a series of 15 images are instantly captured, the number of capturing errors is small.

The light source of the EM-3000 is a long-life light-emitting diode (LED), not the conventional flashlight format, thus eliminating the need for any replacement lamps. This improvement enables continuous capturing and reduces out-of-focus images. When using a conventional non-contact specular microscope, a skilled physician is often needed to finely adjust the patient's eye or face in order to obtain proper images. However, the EM-3000 allows images to be captured comparatively smoothly by anyone, thus freeing the skills of the physician for more important tasks.

An additional advantage of the EM-3000 is its capacity to analyze images soon after capture. The in-built automatic analysis software displays the cell density, cell area, flow co-efficient (CV) value, hexagonal cell appearance ratio, and corneal thickness in less than eight seconds. As the capturing range of 0.25x0.54mm is larger than that of conventional models, more cells can be analyzed. In addition, unique functions are also provided that allow the display

Figure 1: The EM-3000™



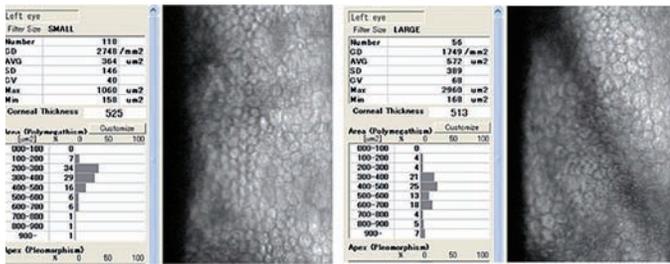
Quickly and automatically analyzes endothelial cell images and displays the image in various modes: endothelial cell image, traced display, area-specific color display, and shape-specific color display.

mode to be changed for different purposes, with specific buttons such as 'traced display' to display the outline of the cell used for automatic analysis, 'area-specific color display' to display cells in different colours that correspond to the area of each cell, and 'shape-specific color display' to display cells in different colors that correspond to the shape of each cell. Furthermore, auxiliary functions are also available for when automatic capturing or analysis is difficult for eyes with corneal diseases or immediately after corneal transplantation. If autoalignment is difficult, capturing can be performed in 'manual' mode. If there are many atypical cells in a captured image or part of the image is out of focus, the manual edit can edit the trace line or analyze when only the clear sections are available. The EM-3000 provides ease of operation, rapid capturing capability, and a large variety of normal and auxiliary analysis functions, and is useful for observing corneal endothelial cells.

Operational Experience for Clinical Applications

In December 2006 and July 2007, we used the EM-3000 to capture images of 112 eyes following penetrating keratoplasty (PKP) and 56 eyes with no keratoplasty—168 eyes in total (75 eyes of 41 male patients and 93 eyes of 59 female patients between 35 and 90 years of age, mean age 68±15 years)—at the Cornea Clinic of the Baptist Eye Clinic, Kyoto.

Figure 2: Endothelial Cell Images Following Penetrating Keratoplasty



Images taken 19 (left) and 12 (right) days after surgery.

Figure 3: Comparison of Manual and Automatic Analysis

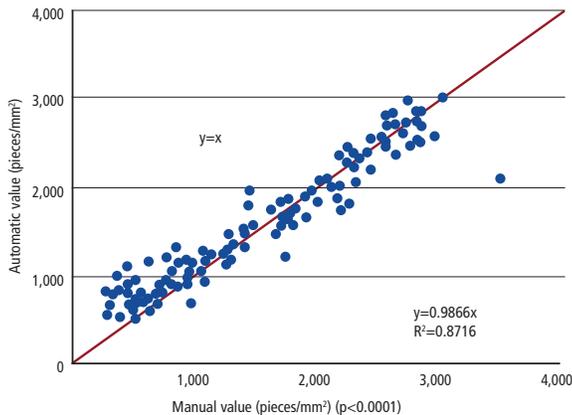
Manual analysis

Manually traces shapes of all endothelial cells visually recognized and analyzes the cell density to identify the true value of the corneal endothelial cell density.

Automatic analysis

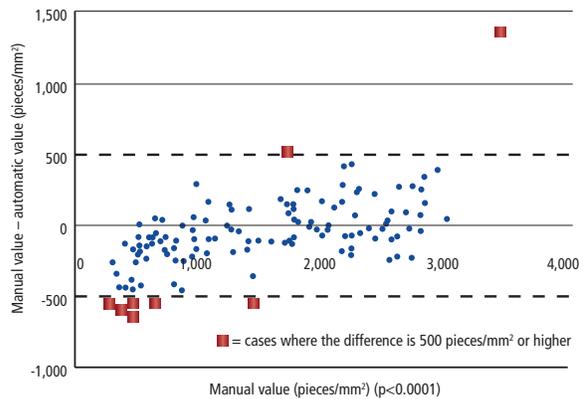
Automatically traces the endothelial cell shape using the automatic analysis program, selects appropriate cells, and analyzes the cell density.

Figure 4: 132 Eye Images Analyzed Using the EM-3000™



In post-keratoplasty eyes it is sometimes difficult to capture endothelial cell images even though the cornea is clear. However, in almost all cases it was easy to automatically capture images when using the EM-3000, and only a support was needed to keep the patient's eye open. Automatic capturing was impossible in only a few cases, but the image could still be captured in manual mode. Historically, it has been difficult to capture a clear image of endothelial cells when using a conventional specular microscope due to factors such as an irregular posterior corneal surface; however, the improved design of the EM-3000 allows for images of those cells to be captured clearly, even in the days immediately following keratoplasty (see Figure 2).

Figure 5: Cell Images Following Keratoplasty



The difference between the manual value and automatic value was 500 pieces/mm² in eight out of 132 eyes (7%).

Figure 6: Corneal Endothelial Cell Images

Manual value	319	395	463	468	643	1,453	1,774	3,472
Automatic value	826	990	1,003	1,108	1,164	1,995	1,215	2,093

(pieces/mm²)

Eight eyes where the difference between the manual eye and automatic eye is 500 pieces/mm² or higher.

Once the images are captured, the EM-3000's built-in analysis software automatically calculates the cell density, cell area, and CV value. To reliably confirm the results of the automatic analysis, we assessed the calculated cell density calculated by manually tracing the shape of all endothelial cells visually recognized on the image that were captured as the true value of the cell density (manual value), and compared this with the density obtained by automatic analysis (automatic value) (see Figure 3).

Of the analyzable images taken by the EM-3000, we recognised a significantly high correlation for 132 of 168 eyes (see Figure 4). However, the difference between the manual value and automatic value was 500 pieces/mm² or more for eight out of 132 eyes (7%) (see Figure 5). The corneal endothelial cell images of those eight eyes were all unclear, so the number of cells that were subject to automatic analysis was small (see Figure 6).

We could confirm that errors may occur in automatic analysis when the captured image is unsuccessful. In such cases, it is effective to delete unnecessary trace lines and/or to add correct trace lines using the edit function of the EM-3000.

Currently, we are in the process of trying to capture images of patients in the early stages after Descemet's stripping automated endothelial keratoplasty (DSAEK) at the Kyoto Prefectural University Hospital. As the LED of the EM-3000 is superior to the conventional flashlight source for continuous capturing, it should allow us to capture good eye images. If so, the EM-3000 will be of further benefit to ophthalmology professionals. ■

Events Diary

October 1–4, 2008

European Association for Vision and Eye Research (EVER) Annual Congress
Portoroz, Slovenia
www.ever.be

October 11–15, 2008

26th Annual Meeting of the American Society of Retina Specialists (ASRS)
Hawaii, US
www.asrs.org

October 18–19, 2008

Association for Continuing Education in Ophthalmology—Glaucoma Meeting
Basel, Switzerland
www.glaucoma-meeting.ch

October 23–25, 2008

European Paediatric Ophthalmological Society (EPOS) Annual Congress
Leuven, Belgium
www.epos-focus.org

October 24–25, 2008

International Interdisciplinary Symposium on Neuro-ophthalmology and Low Vision
Tübingen, Germany
www.amd-read.net

November 8–11, 2008

American Academy of Ophthalmology (AAO) Annual Meeting
Atlanta, US
www.aao.org

November 27–30, 2008

Asia Pacific Association of Cataract and Refractive Surgeons Congress
Bangkok, Thailand
www.apacrs2008bkk.org

January 15–19, 2009

2nd Asia-Association for Research in Vision and Ophthalmology Meeting
Hyderabad, India
www.arvo.org

March 11–14, 2009

XIVth International Congress of the Keratomileusis Study Group
Jalisco, Mexico
www.kmsg09pvr.com

June 13–16, 2009

European Society of Ophthalmology Annual Meeting
Amsterdam, The Netherlands
www.soe2009.org

July 3–5, 2009

11th Aegean Retina Meeting
Crete, Greece
www.aegeanretina.gr

October 24–27, 2009

American Academy of Ophthalmology (AAO) Annual Meeting
San Francisco, US
www.aao.org



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