

# Leading the Way in Specular Microscopy: The SP-1P

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**A**lso known as endothelial microscopy, specular microscopy is a rapid, non-invasive in-office test that employs a photographic technique which enables the viewer to study the size, shape and density of the endothelial cells at the back of the cornea allowing the operator to identify and characterize any abnormalities that may indicate corneal conditions such as trauma, dystrophies, degenerative processes, and follow the condition and health of the endothelial cells. Endothelial cell density refers to the number of cells per square millimetre of corneal endothelium.



The corneal endothelium is the innermost layer of the cornea that regulates corneal nourishment and transparency. The cornea is responsible for a large portion of our eyes focusing power. A damaged

**Figure 1: The Topcon SP-1P Specular Microscope features a fully automatic capture procedure and a modern, ergonomic design.**

cornea interferes with good vision. Although some eye care professionals still rely on a slit lamp to examine the endothelial layer, this approach is rarely adequate as a slit lamp is unable to count the cells or quantify percentage of hexagonality – both important factors in ascertaining the health of the endothelial layer. A low endothelial cell count may indicate a potential condition that could impact the effectiveness of certain procedures such as cataract or refractive surgery and in some cases may require additional surgeries to resolve. Specular microscopy, which works by projecting light onto the cornea, and then capturing the image that is reflected from the optical interface between the corneal endo-

thelium and the aqueous humor<sup>1</sup>, has played an important role in the evaluation of ocular pathology for many years. The early generation of specular microscopes, for example, those described by Laing and colleagues in 1975<sup>2</sup> and Bourne and Kauffman in 1976<sup>3</sup>, had good image resolution and were effective in determining cell density in normal, healthy corneas, but not in those that had already suffered a high percentage of cell loss.<sup>4</sup> Thankfully, specular microscopy has come a long way since then. Topcon Medical System's newest specular microscope, the SP-1P, is able to provide a wealth of information, including central cornea thickness, average cell area, cell density, coefficient of variation, pleomorphism, polymegathism and percentage of hexagonal cells – all in a matter of seconds.

## Why Use Specular Microscopy?

Specular microscopy has a multitude of applications. It can be used to assess the long-time effects of surgery, the action of agents used to treat ocular disorders, and to monitor different conditions of anterior segment surgery.<sup>3</sup> This type of microscope is helpful when identifying ocular conditions, such as glaucoma, Fuch's endothelial dystrophy and uveitis, all of which produce changes in the endothelium and may result in edema or visual impairment.<sup>1</sup> Specular microscopy is also beneficial for cataract patients and corneal transplant patients. For example, in the cataract patient, endothelial cell counts can help predict the risk of post-operative corneal edema. The main scenarios in which eye care providers perform specular microscopy are:

- Pre- and post-cataract surgery

- Laser-assisted in situ keratomileusis (LASIK)
- Penetrating keratoplasty
- Contact lens wear/fitting
- Use of eye drops (e.g., prostaglandins used to treat glaucoma may decrease the endothelium cell density)
- To understand clinical conditions of corneal diseases

## SP-1P: Key Features

The SP-1P Specular Microscope represents the leading edge in non-contact endothelial microscopy technology. Designed with the operator in mind, the SP-1P is one of the most user-friendly, versatile, and advanced endothelial microscope on the market today.

Key features include a wide angle “panorama” photography mode, simple and easy operation, and a 10.4 inch rotatable touch panel monitor



**Figure 2:** The multi-function color screen shows the entire endothelial cell analysis components including original image, analyzed image and the analysis values calculated, as well as a thumbnail of the captured eye.

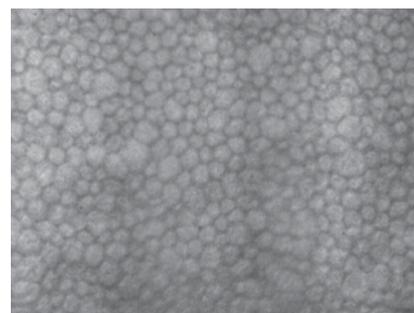
enabling better interaction with the patient - all in a compact and stylish design. The SP-1P also incorporates comprehensive analysis software; it can display the original raw data on the monitor as well as the final report – a feature appreciated by refractive and cataract surgeons.

Additionally, by simply tapping on the center of the patient’s pupil displayed on the monitor, the SP-1P centers, focuses, and acquires the endothelial cell image and travels from one eye to the other automatically.

The SP-1P offers two modalities of capture: the sequence mode and the freestyle mode. With the sequence mode, the examiner can enter patient information prior to photographing and then perform the capture and analysis of the different areas of the cornea; this ensures that all necessary information on the patient is saved. In contrast, the free style mode permits the examiner to start taking pictures immediately after turning on the device. Even during the examination, the operator can change or add the area to be photographed which allows for a more flexible and quick analysis. The entire operation takes a few seconds, is fast and smooth, and requires minimal training – approximately one hour for an experienced technician.

## Panoramic View

One of the most exciting features of the SP-1P is its wide angle panorama photography mode. Conventional non-contact specular microscopes are limited to capturing approximately 0.1 mm<sup>2</sup> (the measurable area varies according to model). However, this measurement range meets only about 0.06% of the total corneal endothelium, and is not accurate enough to observe/analyze the cornea. Additionally, because of the small area of observation, with a traditional non-contact specular microscope, it is difficult to individualize lesions or abnormalities.



**Figure 3:** The “Panorama” function merges three adjacent endothelial cell fields in one single wide field image providing a panoramic view of the endothelial cell layer.

By taking three images - central, nasal and temporal - the “panorama” function of the SP-1P automatically combines those images creating a large area for the observation and analysis of endothelial cells. In fact, the new panorama photography mode featured in the SP-1P can evaluate the number of cells in an area approximately 2.6 times larger than conventional specular microscopy. When a surgeon needs to make a surgical decision on a patient with low cell density, the panorama photography mode with increased statistical analysis of cell count may become an important evaluation tool. Compared to conventional analysis, this large area of cells allows for a more complete evaluation of the patient’s endothelium condition.

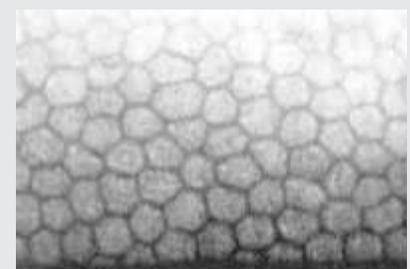
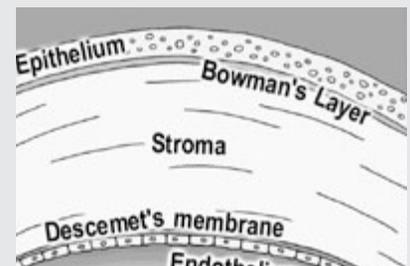
## Conclusion

By providing comprehensive information on the corneal endothelium, it enables ophthalmic practitioners not only to follow the health of the corneal endothelium, but also to diagnose ocular conditions, determine the effect of medication, and predict the likelihood of postoperative complications such as corneal edema. Consequently, the SP-1P is a vital diagnostic tool for optometrists and general ophthalmologists, as well as cataract and refractive surgeons, and corneal specialists.

## WHAT IS THE CORNEAL ENDOTHELIUM?

The corneal endothelium is a monolayer of 350,000 to 500,000 specialized cells that cover the posterior surface of the cornea. One of the endothelium’s physiological functions is to secrete a collagen matrix that forms Descemet’s membrane. However, the primary physiological function of the corneal endothelium is to maintain the health and transparency of the corneal stroma.<sup>1</sup>

A normal endothelium has an average of 2500-3000 cells per square mm and the cells are regular and have six sides (hexagonality). It is known that aging can decrease endothelial cells density (cells/mm<sup>2</sup>). For example in the Japanese population infants have a very high density of cells around 4000-6000 cells/mm<sup>2</sup>. Its outline has consistent and even hexagonal shape. However, as they start aging, the endothelium cell density decreases to 3800 - 3500 cells/mm<sup>2</sup>. There are also racial differences in endothelial cell density; the adult endothelium cell count of Japanese population is said to be around 3000 cells/mm<sup>2</sup>, whereas white adults is said to be around 2700 cells/mm<sup>2</sup>.



## References

1. *Fundus auto fluorescence imaging: review and perspectives.* Schmitz-Valckenberg SI, Holz FG, Bird AC, Spaide RF. *Retina.* 2008 Mar;28(3):385-409. doi: 10.1097/IAE.0b013e318164a907.

Specular microscopy using the SP-1P can provide the following information:

- Central cornea thickness
- Cell density
- Coefficient of variation
- Hexagonality
- Number of cell analyzed
- Minimum cell area
- Maximum cell area
- Average cell area

## References

1. Johnson Bonnell A and Cymbor M. Under the specular microscope. *Review of Optometry* 2012; Issue, 8/15/2012.
2. Laing RA, Sandstrom MM, Leibowitz HM. In vivo photomicrography of the corneal endothelium in keratoconus. *Arch Ophthalmol.* 1975; 93: 143-5.
3. Bourne WM, Kaufman HE. Specular microscopy of the human corneal endothelium in vivo. *Am J Ophthalmol.* 1976; 81: 319-23.
4. Price NC and Cheng H. Contact and noncontact specular microscopy. *Br J Ophthalmol.* 1981; 65: 568-574.



## SP-1P Specular Microscope

- Wide Angle "Panorama" Photography Mode
- Two Specific Photography Modes
- Quick Automatic Measurement and Analysis
- Easy-to-Read Screen and Comprehensive Analysis Software

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