# Specular Microscopy for General Ophthalmologists

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**Abstract :**

Specular microscopy, invented in the later half of the 20th century, has regained gained importance as an essential diagnostic tool for prognosticating the outcome after phaco emulsification and at times even plays a crucial role in deciding which procedure to choose.

**Keywords :**

Specular microscopy, endothelium, cataract, phaco emulsification

Specular in Latin means having the properties of a mirror. David Maurice invented the specular microscope in 1968, the principles of which are utilized in modern clinical microscopes. In 2001, Eye Bank Association of America adopted endothelial cell density as a medical standard, and specular microscopy gained popularity. It is due to the difference between refractive indices of endothelial cells and aqueous humor that 0.22% of the incident light is reflected.[1]

*Figure1: Representative image of a specular microscope*

Specular microscopy is a non-invasive photographic technique that provides a high magnification view of light reflected from the endothelium. According to the orientation, machines can be horizontal-for clinical use or upright for ex-vivo corneal bank use. Furthermore, clinical microscopes can be contact or non-contact. In contact microscopes, due to applanation, the corneal surface is flattened, and hence a more magnified image is obtained since the surface area of the specular reflex depends on the curvature of the reflecting surface. The non- contact ones use auto-focussing [Examples: Konan Noncon Robo (Konan Medical, Japan), CEM-530 (Nidek, Japan), Tomey EM-3000 and EM-4000 (Tomey, United States), Topcon SP-2000P and Topcon SP-3000P (Topcon Corp, United States)]. There are various methods for analysing a specular image, but irrespective of those, accuracy depends mainly on the quality of the image obtained.

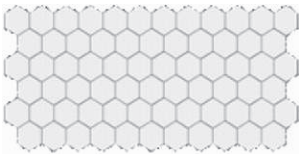

*Figure 2a: Normal Endothelial Cell Density (ECD)*

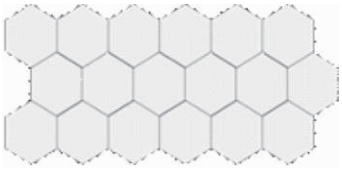

*Figure 2b: Low ECD*

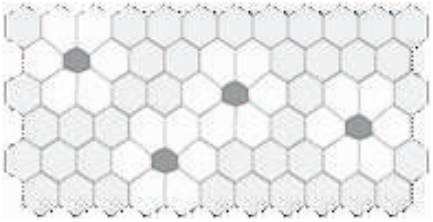

*Figure 2c : Polymegathism*

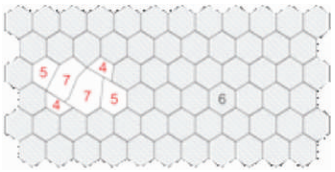


*Figure 2d : Pleomorphism*

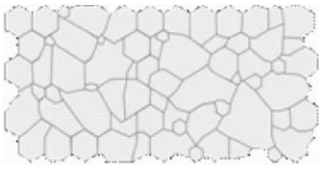

*Figure 2e : Normal ECD with Polymegathism and Pleomorphism*

*(https://www.konanmedical.com/cellchek/specular-fundamentals)*

Endothelial Cell Density **(ECD)** or Cell Density **(CD)** reduces with age due to physiological increase in corneal dimensions

and senescence. Normally it is around 5000-6000 cells/mm$^2$ at birth, but gradually reduces to around 3500 cells/mm$^2$ by the age of 5 years, 3000 cells/mm$^2$ in the late teens and 2500 cells/mm$^2$ in late adulthood. The average cell size is 150-350 µm$^2$ depicted by **AVG** in the report. [2]

Normal endothelial cells are hexagonal. The endothelial monolayer of cells is arrested in the G1 phase and do not regenerate. Thus, to cover for cell loss, they increase in size; this is known as **polymegathism** and is measured by the coefficient of variance (**CV**). CV is the most sensitive indicator for endothelial dysfunction, and normally it is less than 0.30. Normally the percentage of hexagonal cells is more than 60%; however, a deviation of cells from their hexagonal morphology above this level is termed as **pleomorphism** depicted by **'6A'** in the report.

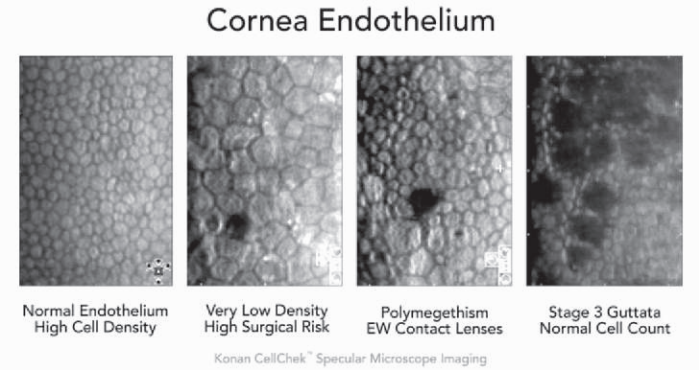


*Figure 3 : Corneal endothelium in health and disease*

**Applications :**

1. Early diagnosis of Fuch's Endothelial Dystrophy.
2. In certain eyes before cataract surgery
   a) Previous trauma
   b) Pseudoexfoliation
   c) Recurrent uveitis
   d) Corneal edema in contralateral eye
   e) Clear graft with operable cataract
   f) Glaucomatous eye with cataract
   g) Subluxated lens, choosing the IOL
   I) Posterior polymorphous dystrophy (PPMD)
   i) ICE syndrome,
   j) Congenital glaucoma
3. Evaluation of donor endothelium
4. Contact lenses and phakic IOLs

It is helpful for endothelial disorders- primary or secondary

**Customization of the Cataract Surgery in a patient with low endothelial count-**

A standard phacoemulsification procedure with controlled fluidics has a very low risk for endothelial damage in patients with soft cataracts, typical anterior chamber depth, and few guttata with no other corneal abnormalities. However, if the nucleus is hard and endothelial cell count is low, then prechopping, ultrasound-sparing techniques (femtosecond laser-assisted, Akahoshi pre-chop, ultrachop,[3] etc.) should be used. Also, during quadrant removal, dispersive OVD injection should be repeated every three to five units of effective phacoemulsification time.[4,5] Zero-ultrasound techniques such as extra capsular cataract extraction or manual small incision cataract surgery should be considered in the cases with very low endothelial cell count, especially avoiding contact between the nucleus and the endothelium, as it can damage the compromised endothelium as normal phacoemulsification.

Viscodynamic extraction is another zero-ultrasound technique that can be used. It involves a sclero-corneal tunnel, small nucleus fragmentation using any method (femtosecond laser,[6] ultrachopper or Akahoshi prechopper), and subsequent fragment removal through the sclerocorneal wound. At the same time, dispersive viscoelastic is injected liberally into the anterior chamber to push the fragments out of the eye. In patients with corneal decompensation, the surgeon should consider a triple procedure with posterior lamella keratoplasty technique of choice.

**Discussing the risk with the patient-**

In today's litigious society, in a patient with poor endothelium, it is imperative to preoperativelydiscuss the risk of pseudophakic bullous keratopathy andsubsequent vision reduction even after successful cataract surgery to avoid any future conflicts. However, documented specular microscopy findings can easily turn the tables in the surgeon's favour even when conflicts arise.

**References :**

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