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Role of Pentacam HR in Corneal and Lens Densitometry

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Abstract

Corneal and lens densitometry measurements provide clinically important information for the evaluation and monitoring of corneal and lens health in different ocular diseases. Pentacam HR (Oculus Optikgeräte, GmbH, Wetzlar, Germany) is a noninvasive optical imaging method that uses a rotating Scheimpflug camera to produce anterior and posterior corneal topographic maps, corneal pachymetry, and three-dimensional analysis of the anterior chamber. It allows objective and quantitative evaluation of the transparency of the lens. With Pentacam HR, lens opacity can be evaluated by obtaining fast, precise, and repeatable lens optical densitometry measurements.

Keywords: Pentacam HR, corneal, lens, densitometry.

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1. Introduction

Obtaining a comprehensive understanding of the structural condition in corneal diseases might be challenging only relying on unprocessed Scheimpflug pictures. The method of tomographic reconstruction was devised to get cross-sectional images along the three main axes. However, because to the non-planar nature of ocular structures, structures in the cornea that are at similar depths can show at various depths in tomography, which makes it difficult to measure them accurately. The corneal densitometry screen is valuable because it displays scatter data on a curved plane that is interpolated between the front and back surfaces of the cornea. This implies that all the structures that can be seen on the map are situated at an equal distance from the surfaces of the cornea. As a result, it becomes a valuable tool for evaluating the depth and location of scattering events that might happen within the cornea [1]. The Pentacam HR, manufactured by Oculus Inc. in Wetzlar, Germany, is equipped with a rotating Scheimpflug camera that can record images without causing any harm, ranging from the front of the cornea to the back surface of the lens. This imaging equipment allows for the evaluation of corneal topography, corneal pachymetry, anterior chamber analysis, and corneal and lens optical densities. Densitometry is a quantitative and reliable method for assessing the transparency of the cornea and lens. It involves measuring the intensity of light that is scattered back from various areas of these structures.

Even in corneas and lenses that appear transparent in clinical settings, it is possible to find high densitometry values that are linked to an increase in backward scattering. Consequently, it has been employed in numerous recent investigations to assess the well-being of the cornea and lens [2]. The Pentacam HR (OCULUS, oculus.de) has gained widespread recognition as a standard for assessing corneal densitometry over past ten years, due to its global availability in clinics. This offers a potent tool for studying both normal corneas and ocular conditions such as keratoconus, Fuchs endothelial dystrophy, dry eye, pellucid marginal degeneration, extreme myopia, or glaucoma. Wearing contact lenses can cause a little decrease in oxygen levels, which has been linked to a temporary rise in backscatter [3]. Corneal densitometry has been linked to the presence of the disease in multiple myeloma, Fabry disease, and other uncommon disorders. Corneal densitometry has been useful in assessing the structural integrity of the cornea following refractive surgery, corneal crosslinking, and trabeculectomy. Aside from eye problems and diseases, studies have shown that corneal densitometry tends to rise as a person gets older. However, there is no observed relationship between corneal keratometry and refractive parameters [4].

2. The clinical utility of corneal densitometry

Densitometry examination, when conducted under consistent settings, can be utilized to obtain consistent and replicable measurements of corneal haze. Densitometry measures have been utilized to monitor corneal haze in patients after undergoing LASIK or PRK procedures, or those with infectious keratitis, corneal mucopolysaccharidosis, and

Keratoconus. The scan technique is uncomplicated and does not extend the duration of the Pentacam® scan [5].

3. Applications and Limitations

The densitometry approach can be used to objectively analyze any condition that causes corneal haze or opacity, as long as the cornea is not completely opaque. Excessive haziness or opacity of the cornea will result in elevated backscatter levels, rendering the data inaccurate. Peripheral corneal densitometry increases with age, but central corneal densitometry remains steady [6].

1) Keratic precipitates

A 50-year-old individual appeared with a medical background of granulomatous uveitis caused by a toxoplasmosis infection. Upon initial examination, it was observed that he had a significant number of big keratic precipitates accumulated on the endothelium surface. The innermost layer of the densitometry scan has significant big precipitates, as shown in Figure 1. Slit lamp photography was not very effective in capturing images of the precipitates because it was impossible to specifically target the endothelium surface using retroillumination (Figure 2). After initiating treatment with antibiotics and corticosteroids, the patient exhibited notable clinical improvement (Figure 3). During the two-week follow-up session, there was complete resolution of the preceding keratic precipitates (Figure 4) [7].

2) Position and depth of INTACS® rings

As mentioned in other sections of this Interpretation Guide, Pentacam® tests are highly valuable for surgical planning and post-operative patient monitoring. The inclusion of densitometry screening can provide an additional dimension to the follow-up process. A 35-year-old individual with a previous record of stable keratoconus underwent a procedure including the insertion of INTACS® corneal ring segments. The segments are clearly apparent on the densitometry screen (Figure 5). The depth of the rings can be observed, quantified, and monitored over time, with all measurements obtainable from a single Pentacam® scan [8].

3) DSAEK with specks at the interface

Haze at the interface between the donor cornea and the recipient cornea is a common complication that can lead to a poor visual result in DSAEK surgery. The densitometry screen's ability to represent any desired layer allows for a more thorough examination of the lamellar interface. Upon examination of an 80-year-old woman, it was discovered that the visual result was somewhat below the anticipated outcome. Further investigation revealed the presence of small particles or deposits of inflammatory material at the interface. The densitometry approach facilitated the acquisition of unbiased measurements of this stratum (Figure 6) [9]. A cross-sectional comparative study was conducted to analyze the corneal and lens densitometry in 23 children diagnosed with Nephrotic Syndrome (NS) in comparison to 26 healthy individuals. The Pentacam HR was used for this purpose. The investigation revealed notable disparities in keratometry, horizontal white-to-white measurement, and iridocorneal angle values between the two groups. More precisely, the measurements of corneal densitometry in the front part of the eye were shown to be considerably greater in patients with NS, particularly in the 0-2 mm and 2-6 mm areas.

While lens densitometry values were elevated in NS patients in all zones, these changes did not reach statistical significance. The results indicate that NS and its treatment linked to alterations in the density of the cornea and lens, specifically in front part of the cornea and the center area measuring 0-6 mm. These changes are a result of the duration of the disease, the frequency of relapses, and use of steroids [2]. In a different cross-sectional, case-control investigation, levels of corneal light backscattering in all layers and zones of the cornea were found to be comparable between groups of patients & controls. The lens densitometry readings in 3 zones showed no significant difference between 2 groups ($p > 0.05$). The patient group had substantially greater maximum lens densitometry values compared to the control group (22.14 vs 19.11; $p = 0.011$). Utilizing Pentacam to monitor cornea and lens density in FMF patients can assist in detecting subclinical inflammation and managing subsequent follow-up and therapy procedures [10].

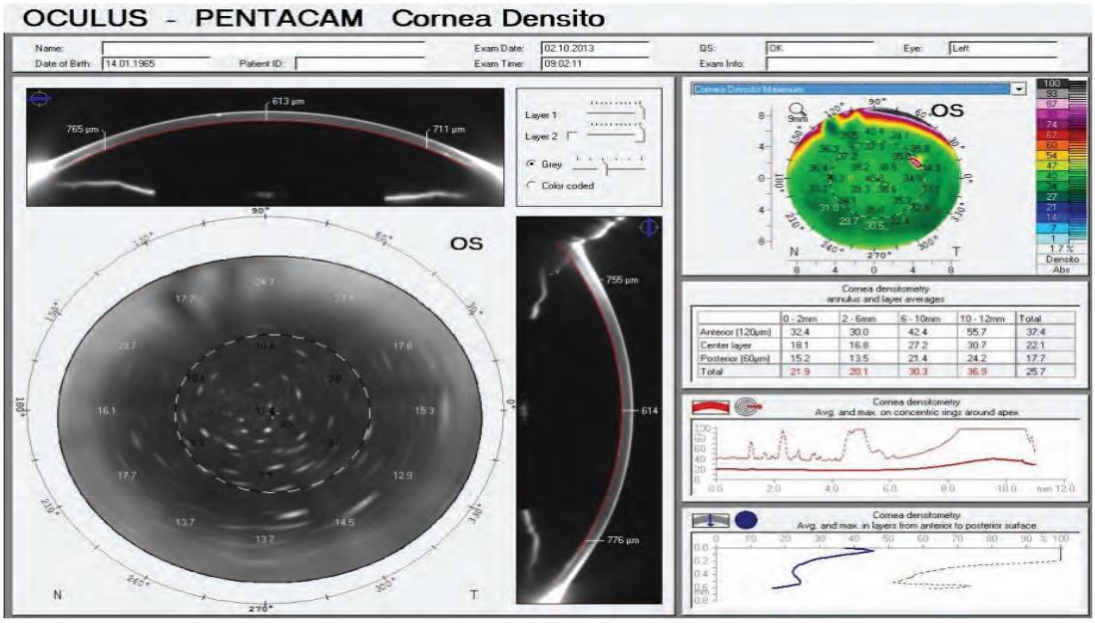

Figure 1: Corneal Optical Densitometry display showing a patient's endothelial densitometry at his initial presentation

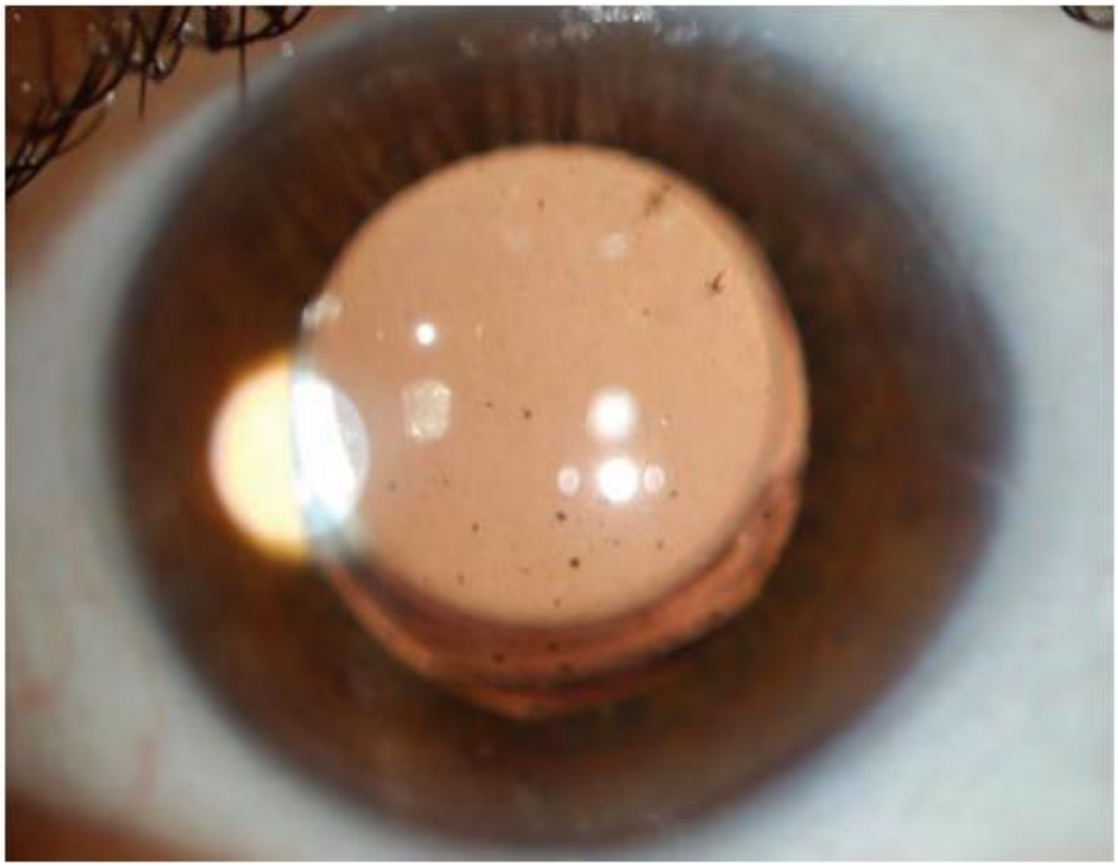

Figure 2: Slit lamp photo of the same eye at the patient's initial presentation

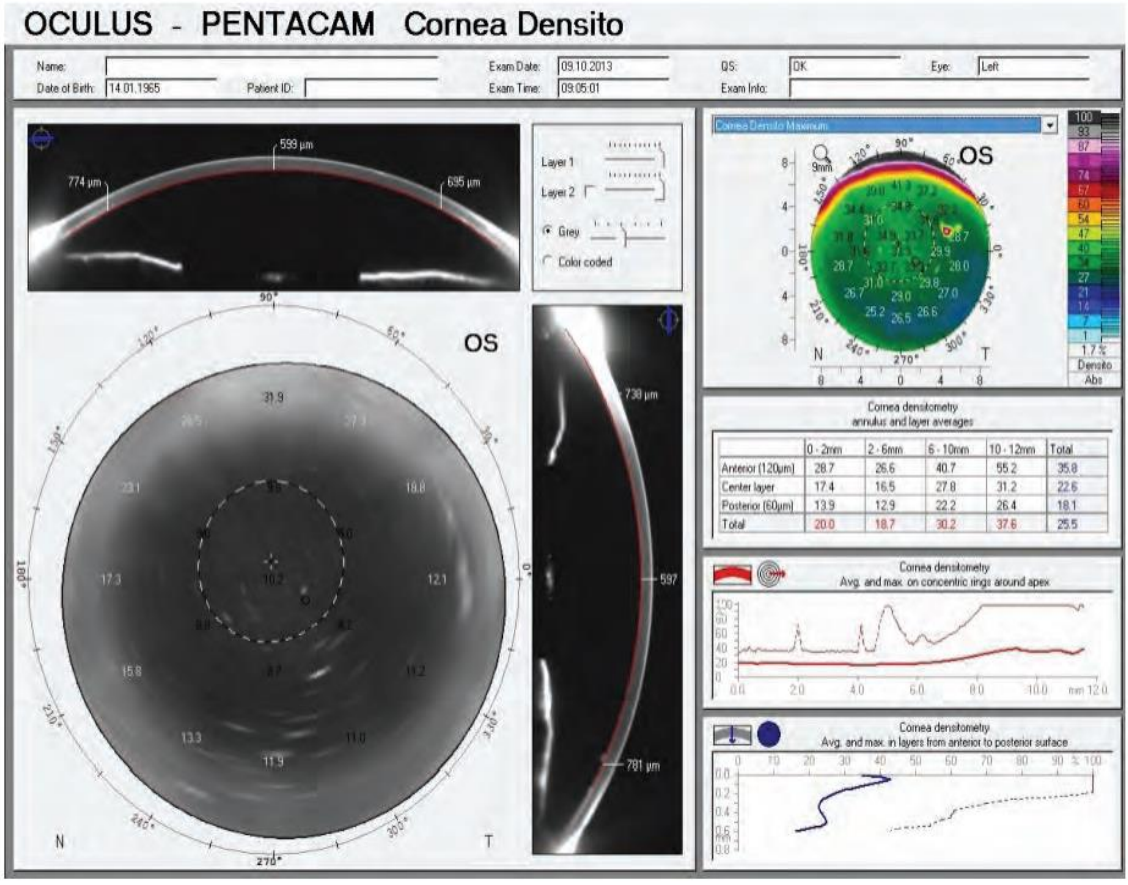

Figure 3: Corneal Optical Densitometry display showing keratic precipitates after one week of therapy

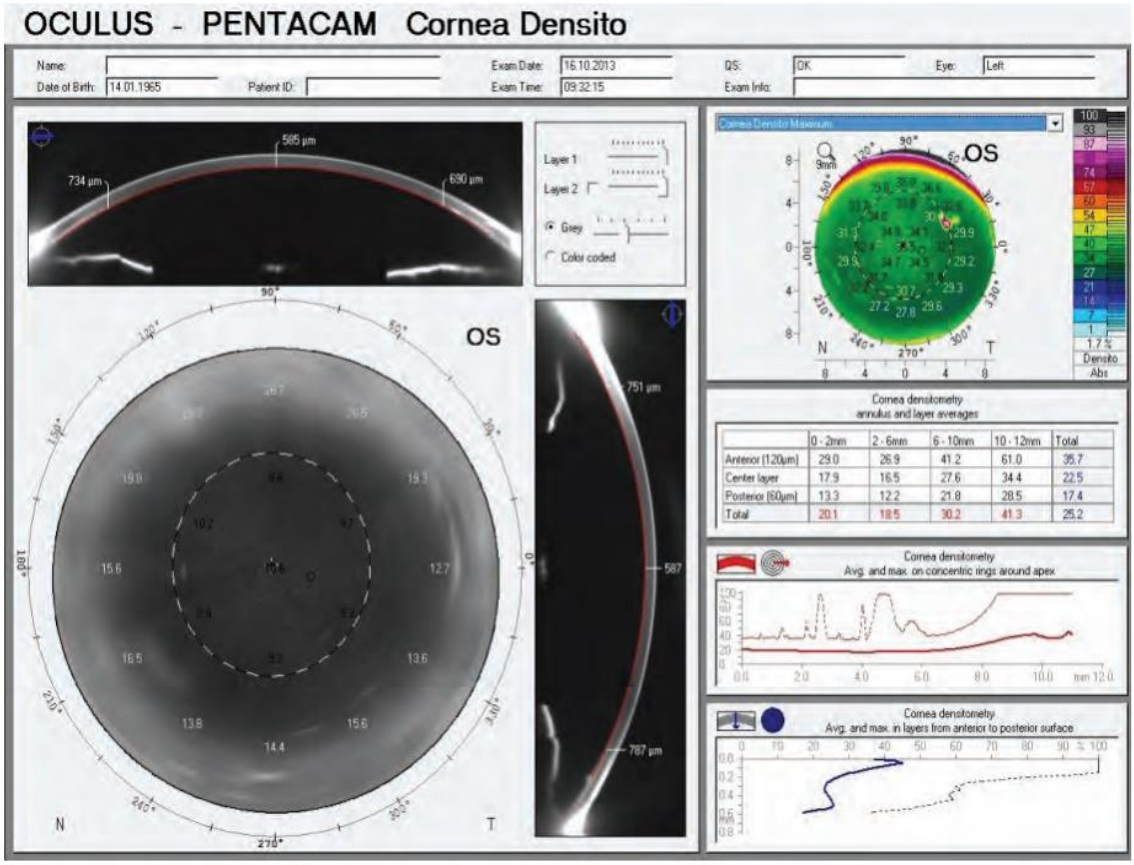

Figure 4: Corneal Optical Densitometry display showing keratic precipitates after two weeks of therapy

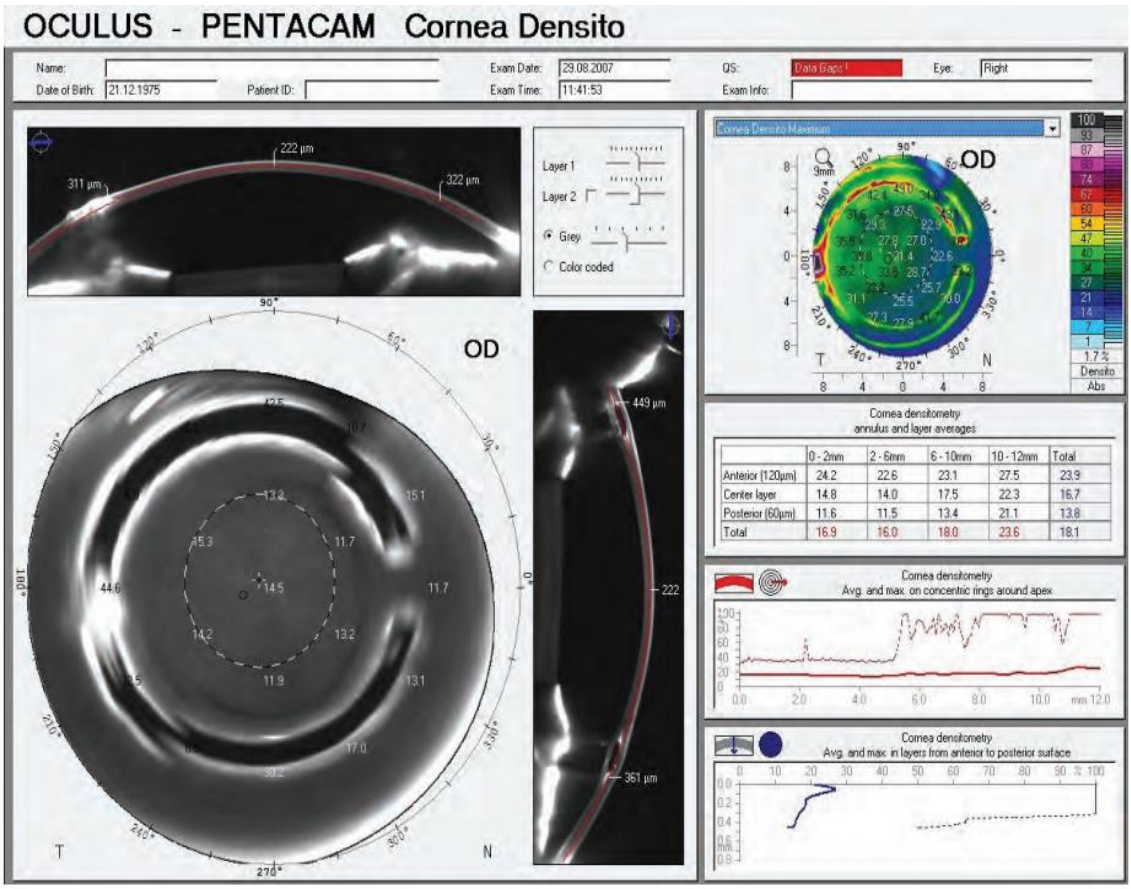

Figure 5: Corneal Optical Densitometry display showing the position and depth of INTACS® corneal ring segments

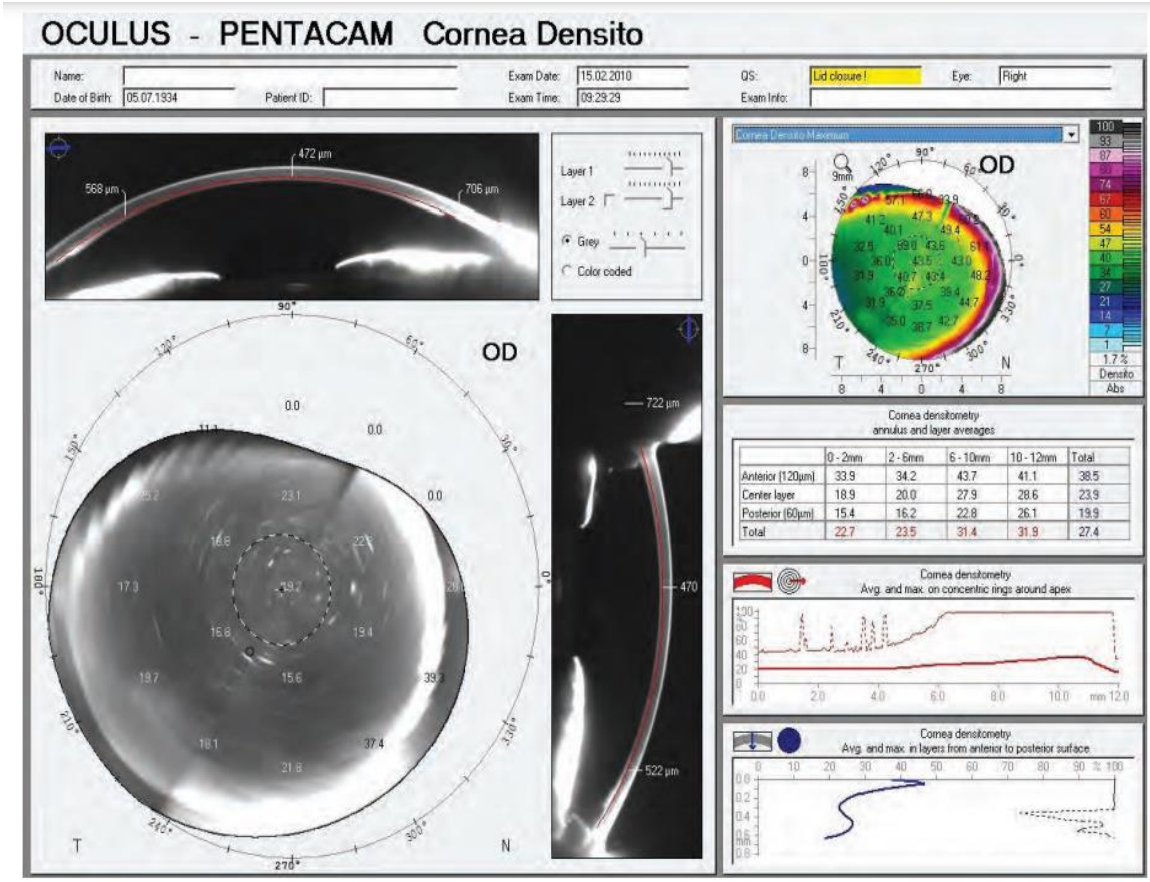

Figure 6: Corneal Optical Densitometry display showing specks and precipitates at the lamellar interface post DSAEK

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