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Intraocular lenses for presbyopia correction: indications, contraindications, and tips for success

OPD in the cataract surgeon's practice

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SUMMARY

OPD in the cataract surgeon's practice

The OPD-Scan III, manufactured by Nidek Co. (Gamagori, Japan), is a piece of equipment that unites a Plácido ring topography with a dynamic skiascopy aberrometry. Therefore, it is able to generate data on both the cornea's anterior surface and the net aberrometry of the studied eye. It is very interesting to note that from the aberration derived from the topography, the device is able to create an internal aberration map (total ocular aberrations - corneal aberrations). Here's my first tip: when the device says internal aberrations, it understands everything that is happening in the patient's eye from the cornea's anterior surface to the retina. Therefore, in the majority of cases, such a map expresses optical alterations generated well through the crystalline (Figure 1). However, in some cases, it is just showing the aberrations originating on the cornea's posterior surface (Figure 2), especially in very irregular corneas.

For the cataract surgeon, the OPD-Scan III acts as a great ally in preoperative decision-making and in choosing the ideal intraocular lens for the case by bringing a series of relevant pieces of information in just one exam. The biggest problem, mainly for doctors who are unfamiliar with the device, is that the large quantity of information often confuses them, generating difficulties in interpreting the exam. So, a few years ago, I developed a systemic analysis of the exam with parameters and a fixed order, creating an analysis flow chart that tends to make all of our lives easier.

Said flow chart consists of the analysis of the following data:

1. Plácido Rings
2. Pupil size
3. Kappa Angle of Mu Chord
4. Astigmatism
5. Spherical Aberration
6. Coma

For analysis, we need at least native maps from the device: Cataract Summary and Pupil Summary. But, as always, my recommendation is to create a map with all of the necessary data on just one page (Figure 3). We will discuss each point on the flow chart below.

1. PLÁCIDO RINGS (PUPIL SUMMARY)

The first step to always be taken to analyze Plácido rings topography is to check the photo for its own rings to be sure that the exam was performed with adequate quality. The reflection of the rings is very sensitive to ocular surface alterations, or at least the errors in the test preparation (the patient was not properly instructed to blink, for example). Poorly defined rings or rings with visible breaks will not generate quality maps and, therefore, the exam will need to be redone. In the event the alterations remain, it is probably that the patient is a carrier of surface diseases that require being treated before phacoemulsification. It's worth remembering that patients with dry eye present relative contraindication for the implantation of diffractive intraocular lenses and the image of the rings may be the first diagnostic clue in these cases.

2. PUPIL SIZE (PUPIL SUMMARY)

For any and all optical systems, the opening is essential for quality image analysis. Systems aberrated and no collimated (with non-concurrent axes), as the human eye, present a worse image quality directly proportional to the opening. That is, save for the rarest exceptions, the image quality observed for our patients tends to be and is worse the larger the size of the pupil. That is easily perceived when analyzing the high order aberrations of the same patient with different analysis areas.

As a rule, the quantity of aberrations is greater and the point spread function (PSF) is worse. The curves of the Modular Transfer Function (MTF) are also worse in analyses under mesopic conditions (Figure 4) when compared to the same eye under photopic conditions (Figure 5). Additionally, patients with very large pupils tend to have greater incidences of photopsia (halos, glare, starburst) after diffractive IOL implantation, and this data should be taken into consideration during the preoperative analysis.

Conversely, very small pupils may also generate problems. By decreasing the amount of optical energy found in the retina, patients with very small pupils present lower contrast sensitivity levels. Moreover, when combined with diffractive IOL implantations, they do not generate an adequate area for the use of diffractive rings, with consequent lower near vision potential. It is worth mentioning that this loss in near vision capacity may be partially neutralized by increasing the focus depth caused by the small opening (pinhole effect).

The ideal pupil size varies from IOL to IOL. But, in

Author

IVAN CORSO TEIXEIRA

Head of the cataract sector of the H.Olhos Paulista Group. Hired assistant of the cataract sector of Santa Casa de São Paulo.

Section Publisher

RACHEL GOMES

Ophthalmologist specialized in cataract surgery and surgical optics. Ph.D. in Ophthalmology from Unifesp. Post-doctorate through TUFTS New England Eye Center, Boston. Director of Cataract at ABCCR/BRASCRS and associate editor of the journal Oftalmologia em Foco.

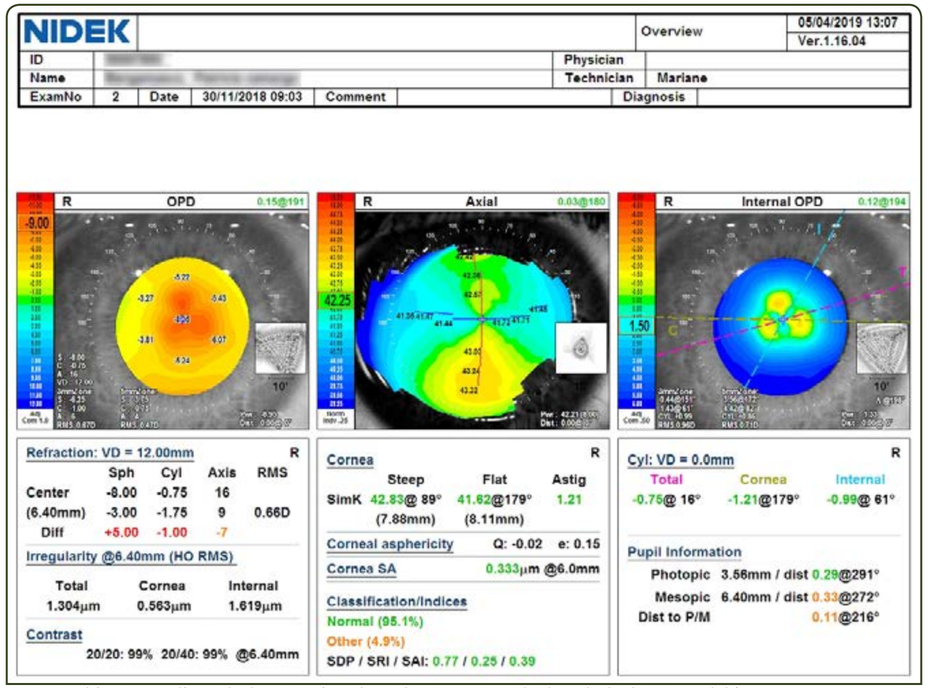


Figure 1 - Internal aberrations caused by central nuclear cataract. Observe the central zone more convergent than the peripheral on the OPD map to the left

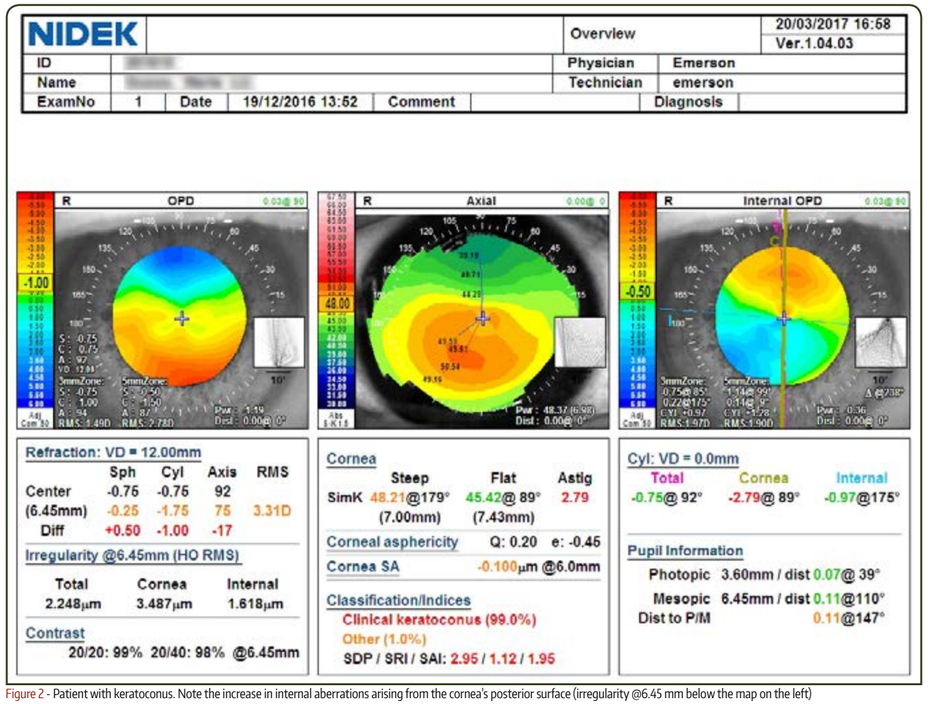


Figure 2 - Patient with keratoconus. Note the increase in internal aberrations arising from the cornea's posterior surface (irregularity @6.45 mm below the map on the left)

general rules, for diffractive IOL indication, photopic pupils greater than 2 mm and mesopic pupils less than 6 mm will not cause problems in the postoperative period (Figure 6). The pupil diameters outside this range are not absolute contraindications either, in my view. However, it is essential to explain this fact to the patient, with his/her subsequent consent.

3. KAPPA ANGLE AND ALPHA ANGLE (PUPIL SUMMARY)

As stated previously, the human eye is a non-collimated system. Its anatomic and optical axes are not coincident. This isn't a major problem, because all human image processing already takes this into account, thus reducing its consequences. For the cataract surgeon, "intraocular misalignment" analysis is essential. We know that diffractive lenses present a central ring into which the patient's visual axis should be inserted. We also know that IOLs are developed to remain centralized in the patient's capsular bag.

Therefore, if the patient's optical axis is not passing through the center of the capsular bag, it will also not pass through the center of the intraocular lens. Thus, the system's optical quality will be less than ideal, which in practice translates into less sensitivity to contrast postoperatively. Low visual acuity may occur in these cases, but it is not commonplace. In negative asphericity lenses, when there is IOL decentralization, the loss of its asphericity and coma induction also occur. As such consequences are difficult to measure and normally they do not affect visual acuity, they are often neglected by us, ophthalmologists even though it is not a rare entity.

The OPD-Scan analyzes two analogous measurements at visual angles. The first is the distance from the center of the pupil to the first Purkinje reflection, called the Chord Mu, or the Chang-Waring Chord.[1] This measurement is similar to the real kappa angle of the analyzed eye. I will not go into technical details about such an approach, but if you are interested in going deeper into the topic, I suggest you read the reference cited previously.

The second measurement is the relationship between the center of white-to-white horizontal distance and the first Purkinje reflection. Such a measurement would be the most exact because the white-to-white maintains a better correlation with the anatomy of the capsular bag than the pupil. However, we note that the OPD-Scan III's automatic white-to-white measurements, in practice, are quite inconsistent. Therefore, as your standard measurement, I suggest visually checking the device's white-to-white measurement. At my practice, I still opt for the alpha due to such problems.

In diffractive IOL implantations, therefore, we should choose patients who present the chords relative to the alpha or kappa less than half of the central diameter of the IOL to be implanted. All of these measurements are found on the Pupil Summary (Figure 7).

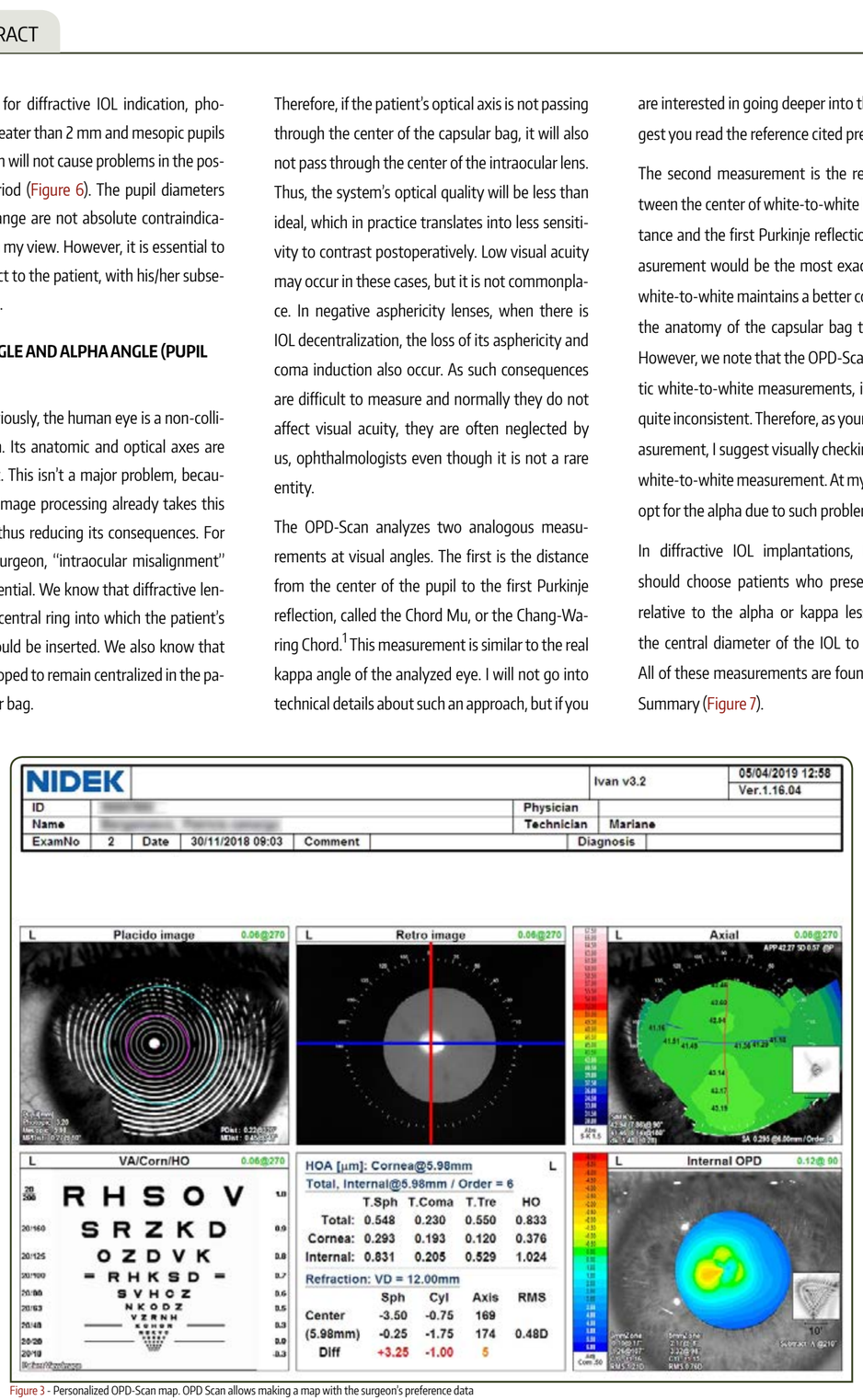
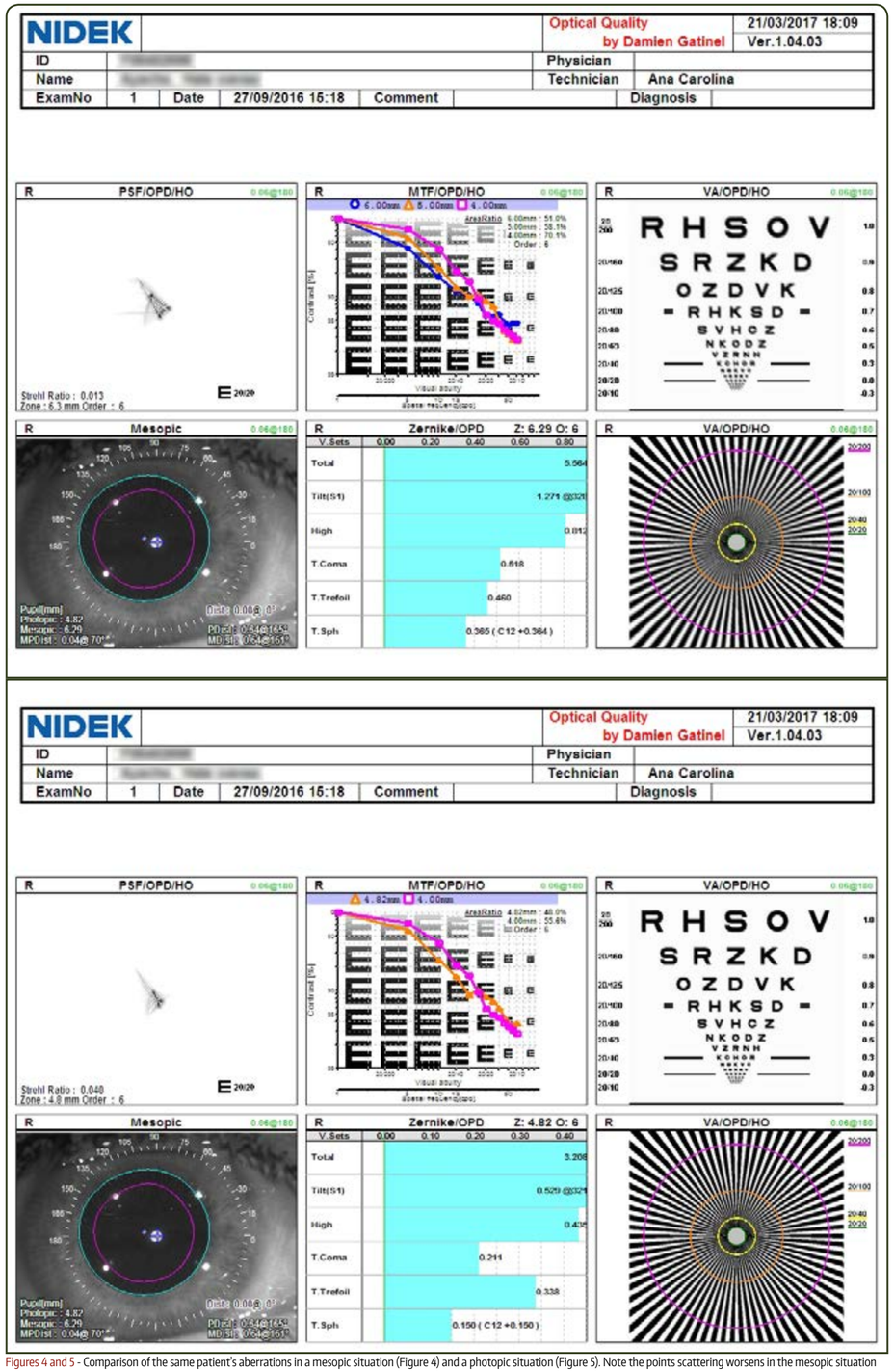


Figure 3 - Personalized OPD-Scan map. OPD Scan allows making a map with the surgeon's preference data



Figures 4 and 5 - Comparison of the same patient's aberrations in a mesopic situation (Figure 4) and a photopic situation (Figure 5). Note the points scattering worsens in the mesopic situation

OF CATARACT

4. ASTIGMATISM (CATARACT SUMMARY)

All phacoemulsification candidates should be submitted to a quantitative and qualitative corneal astigmatism analysis. I will not go into details about toric or diffractive-toric lens indications, however, I will provide some tips:

A) If there is a definable axis, there is a toric lens indication.

B) Try to correlate astigmatism with the pupil size. A classic example is patients with pellucid marginal degeneration and small pupils. The patient presents with an irregular cornea, however, when the area of the cornea relative to the pupil is analyzed, the astigmatism is relatively regular and correctable (Figure 8).

C) Always use the keratometry and astigmatism axis values measured by your trusted biometer. Check if the values are similar to those found on the OPD. In case there is a lot of difference, repeat both. And if the difference stays the same, evaluate with calm if there really is an indication for a toric lens IOL. If the answer is yes, use the keratometry values taken by biometer and the axis found on the OPD-Scan. It is worth mentioning that this last one is a personal practice of mine, without scientific proof.

D) In irregular astigmatisms that you decide to implant toric IOLs, I suggest hypocorrecting the value obtained by the Barret calculator.

E) Irregular astigmatism is a contraindication for diffractive lenses.

F) Remember to correct low order astigmatism, especially counter-rule, in diffractive IOL implants. Residual astigmatisms above 0.75D greatly decrease these patient's optical quality. It is worth remembering that the main cause of dissatisfaction with diffractive IOLs is residual ametropia.

5. SPHERICAL ABERRATION (CATARACT SUMMARY)

Out of all of the high order aberrations, just the spherical aberration (SA) is correctable (though only partially) with the use of intraocular lenses. It is known that patients with very altered spherical aberrations present a decrease in visual quality (contrast sensibility and halo vision), but also low final visual acuity. This effect is greater the larger the pupil of the patient. Therefore we should always look for the least spherical aberration amount possible.

The mean spherical aberration of the normal population is +0.27 µm. According to previous studies, the ideal amount of spherical aberration in one pseudophakic patient revolves around +0.1 µm. Evidently, it is not necessary to endlessly search for the smallest possible spherical aberration, because there is no wide range of corrections available among IOLS (Figure 9). What I recommend is to avoid making the patient's situation worse. This is more perceptible in cases of patients with previous refractive ablations. Patients submitted to myopic ablations tend to have positive SA and negative

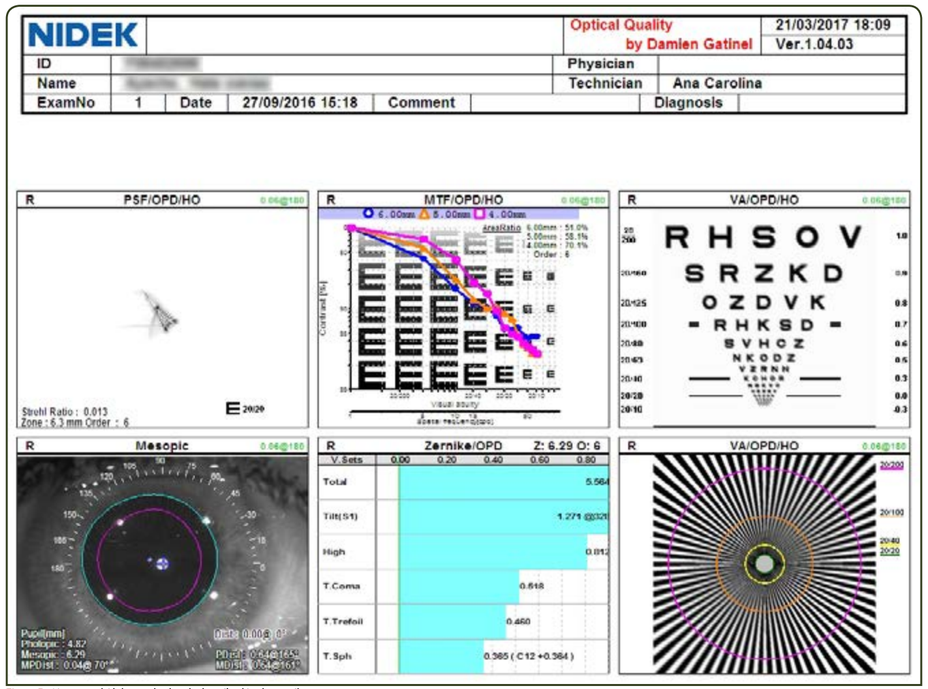


Figure 7 - Kappa and Alpha angle chords described in the pupil summary

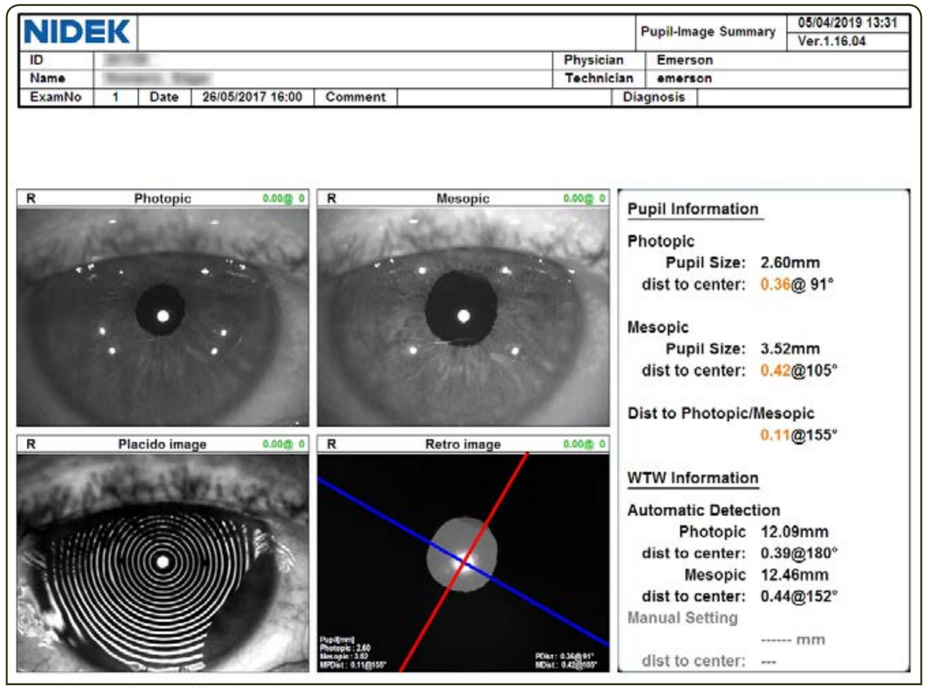


Figure 6 - Ideal pupil size for a general diffractive lens implantation

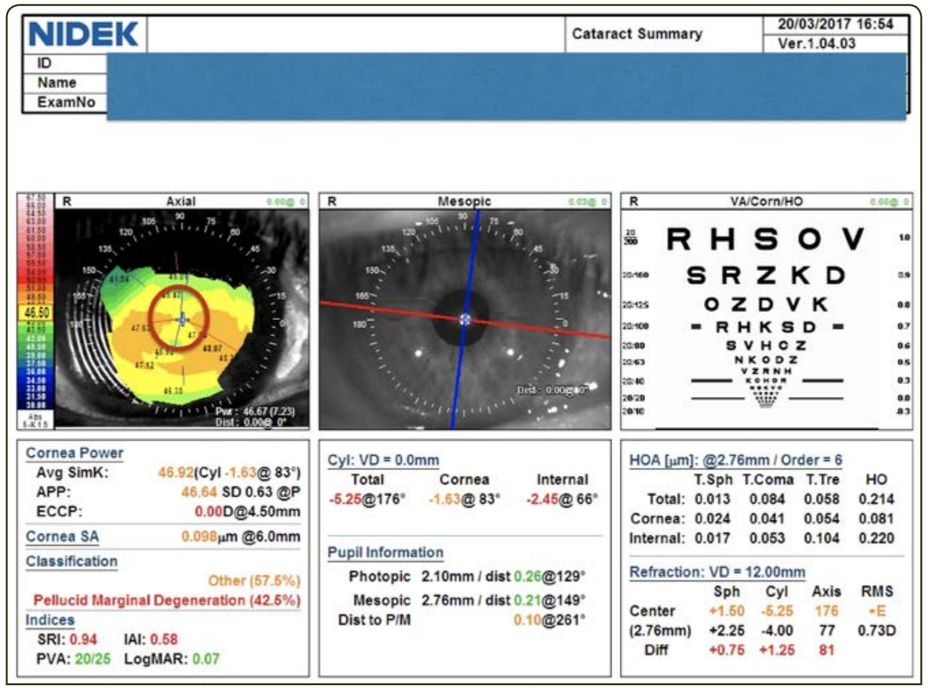


Figure 8 - Patient with pellucid marginal degeneration and a small pupil. In this case, as the corneal region used by the patient presents a definable axis, toric IOL implantation is possible

hypermetropics (Figure 10). Therefore, patients with hypermetropic ablations benefit from spherical IOLs and myopic patients benefit from negative asphericity IOLs.

Unfortunately, the majority of toric and diffractive IOLs present negative asphericity. In toric cases, it is worth remembering that we should give priority to the correction of low order aberrations (such as astigmatism - and only after think about high order aberrations. Therefore, in a patient with negative spherical aberration and astigmatism, it is best to correct their astigmatism even though you know that their spherical aberration will worsen. In diffractive lenses, the negative spherical aberrations are a relative contraindication. Not all post-ablation hypermetropic patients will be good candidates. In myopic ablations, if the patient does not have very high SA values (great than +1 µm), the diffractive IOL implant is less complex.

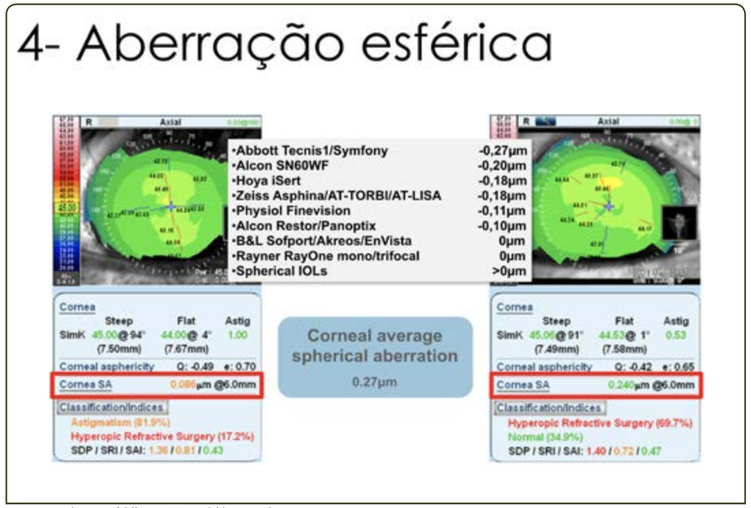


Figure 9 - Asphericity of different IOLS available in Brazil

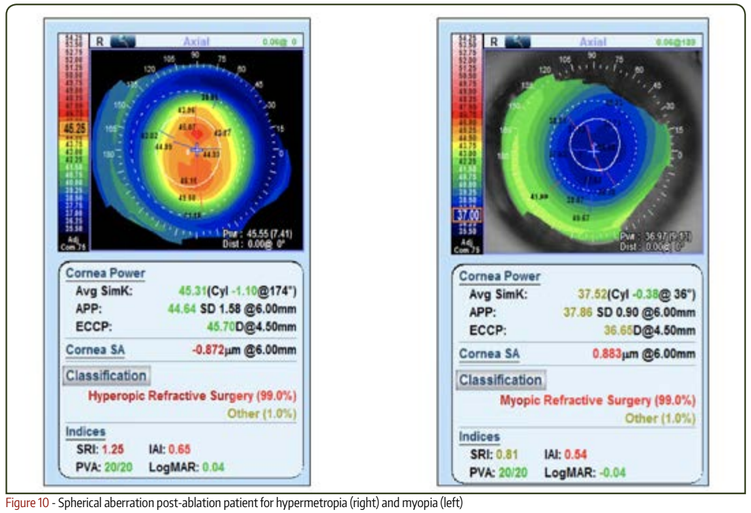


Figure 10 - Spherical aberration post-ablation patient for hypermetropia (right) and myopia (left)

6. COMA (CATARACT SUMMARY)

Such as the spherical aberration, the coma is high order aberration. However, we cannot unfortunately correct this with any type of intraocular lens. To make matters worse, within the high order aberrations, the coma is the one with the greatest potential to diminish quality postoperatively. Therefore, it is interesting to evaluate the amount of corneal coma in our patients. We never use the examined eye's total cornea, because it takes into account changes generated by the crystalline lens that will be removed. Therefore, we should evaluate the corneal coma.

The "magic number" for the corneal coma with these patients is 0.3 µm for a 4 mm pupil.[2] The larger the pupil, the larger the coma, even in "normal" corneas (Figure 11). In practice, I note that the values up to 0.5 µm main a good quality of vision even with diffractive IOLs. Above that (Figure 12), both the visual acuity and the contrast sensitivity progressively worsen. Again, the smaller the pupil, the better the quality of vision.

CONCLUSION

The OPD-Scan III is an excellent tool for the preoperative evaluation of our patients with cataracts, mainly for diffractive IOLs indications. By following this guide it is possible to select better patients, improve the postoperative satisfaction index, and decrease the occurrence of undesirable surprises. Should you always associate these suggestions with an adequate "chair-time" and a proper surgical technique, then your results will be very interesting.

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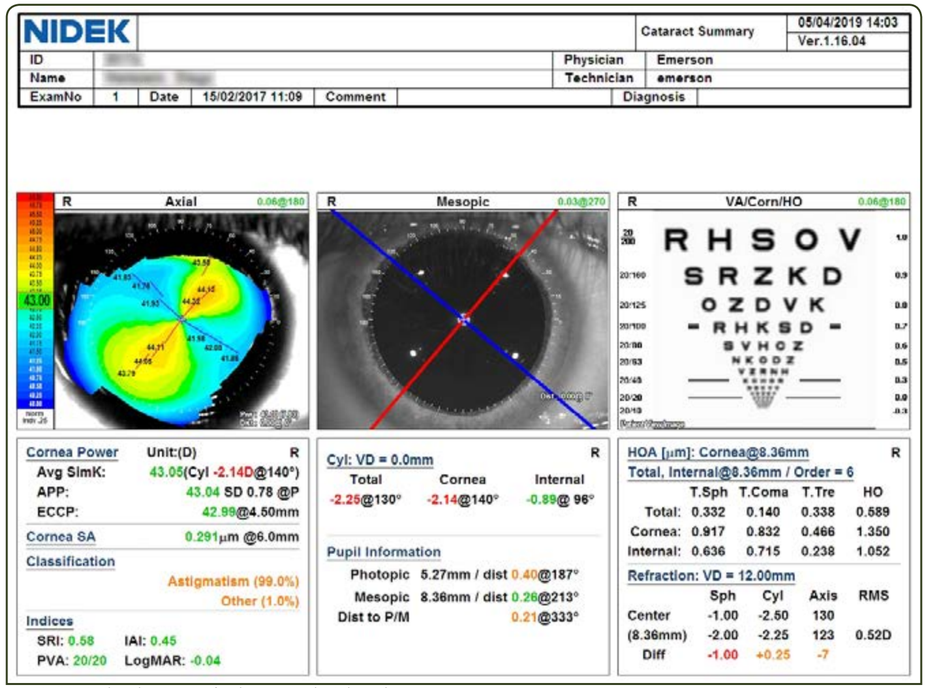

Figure 11 - Patient with regular astigmatism but also presenting elevated corneal coma

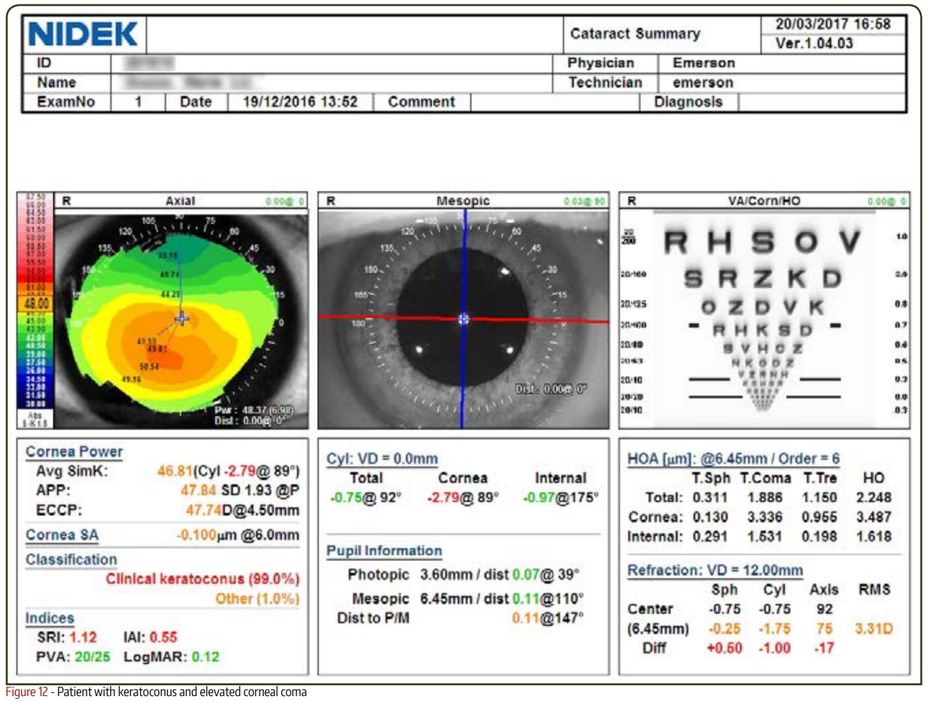

Figure 12 - Patient with keratoconus and elevated corneal coma