Incorporating Optical Coherence Tomography in the Cataract Preoperative Armamentarium: Additional Need or Additional Burden?

ADITYA SUDHALKAR, VIRAJ VASAVADA, DEEPAK BHOJWANI, C.V. GOPAL RAJU, P. VASUDEV, SHRADDHA JAIN, AND MAMIDIPUDI R. PRAVEEN

• **PURPOSE:** To determine the usefulness of preoperative optical coherence tomography (OCT) examination to detect asymptomatic macular abnormalities in patients scheduled for cataract surgery.

• **METHODS:** Design: Prospective, interventional case series. Setting: Iladevi Cataract and Visakha Eye Center, Ahmedabad, India. Study Population: Patients undergoing cataract surgery and intraocular lens (IOL) implantation for senile cataracts. Preoperatively no retinal/macular pathology was identified on clinical evaluation. Intervention: All eyes underwent macular 5-line raster evaluation using spectral-domain OCT before and after cataract surgery (monthly for 3 months). Central subfield thickness (CST) analysis was done. Outcome Measures: The primary outcome measure was determining the incidence of asymptomatic retinal lesions on OCT examination in clinically "normal" maculas. Secondary outcome measures included documenting change in corrected distance visual acuity and OCT thickness postoperatively.

• **RESULTS:** A total of 1444 eyes were evaluated. OCT revealed asymptomatic lesions in 133 (9.21%) patients. At 3 months, all eyes showed significant median visual improvement (from 0.45 ± 0.13 logMAR to 0.06 ± 0.08 logMAR; $P = .015$) and insignificant median CST change (from 223.34 ± 21.1 μm to 249.12 ± 19.24 μm; $P = .19$). One eye showed increased vitreomacular traction (3 months). Patients with asymptomatic lesions did not have significantly worse postoperative visual outcomes at 3 months (from 0.52 ± 0.16 logMAR to 0.14 ± 0.1 logMAR; $P = .12$).

• **CONCLUSION:** A total of 9.21% patients with clinically normal maculas had subtle pathology detected on OCT, but this subset of patients did not have worse postoperative visual outcomes compared to eyes with normal OCT scans. Thus, a careful pre–cataract surgery fundus examination remains an essential part of the presurgical patient evaluation. (Am J Ophthalmol 2019;198: 209–214. © 2018 Elsevier Inc. All rights reserved.)

Cataract management has been revolutionized by the introduction of phacoemulsification,[1] femtosecond laser–assisted cataract surgery,[1] correction of corneal astigmatism, the use of advanced-technology intraocular lenses,[2] and the use of aberrometry[3] for the customization of postoperative outcomes. These advances have added precision, accuracy, and consistency to postoperative outcomes. At the same time, they have increased patient expectations, and the onus is on the cataract surgeon to minimize postoperative surprises and build "realistic" expectations for each eye. Retinal disease (and in particular macular pathology) has the potential to be the proverbial fly in the soup and with the ready availability of spectral-domain optical coherence tomography (OCT), it seems logical to incorporate preoperative OCT assessment (as a supplement to clinical fundus evaluation) in the diagnostic armamentarium.

Subtle macular pathologies are often the cause of an unhappy patient following a perfect surgical outcome.[4,5] Binocular indirect ophthalmoscopy (BIO)[6] and slit-lamp biomicroscopic evaluation of the posterior pole (with a +90/+78 diopter [D] lens) is unquestionably an important skill in the ophthalmic surgeon's armamentarium, but familiarity with the procedure, cost of referral, media opacities, and the power of resolution of the naked eye limit its usefulness in certain situations. Also, certain subclinical conditions that may become significant postoperatively (such as clinically significant macular edema or an epiretinal membrane) may be missed on routine preoperative retinal evaluation.[7–9]

Optical coherence tomography has become an essential tool for the retinal surgeon to diagnose clinical and subclinical macular lesions as well as monitor treatment outcomes in patients with macular pathologies.[4,10] It is also known that spectral-domain OCT can pick up vitreoretinal interface abnormalities (epiretinal membranes, lamellar macular holes, etc), which may often be missed during a clinical examination.[7] While cataract surgeons take note of the role of corneal topography[11] and the tear film and ocular surface[12] in their preoperative planning of cataract surgery, objective documentation of macular integrity is

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From the Raghudeep Eye Hospital, Iladevi Cataract Centre, Ahmedabad, India (A.S., V.V., D.B., S.J.); and Visakha Eye Centre, Peddawaltair, Visakhapatnam, India (C.V.G.R., P.V., M.R.P.).

Inquiries to Aditya Sudhalkar, Raghudeep Eye Hospital, Iladevi Cataract & IOL Research Centre, Gurukul Road, Ahmedabad 380054, Gujarat, India; e-mail: adityasudhalkar@yahoo.com

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vital to a satisfactory postoperative outcome. OCT analysis thus is an important tool for cataract surgeons. Klein and associates[4] have demonstrated the utility of the posterior segment spectral-domain OCT scan in determining eligibility for multifocal and toric lenses.

We conducted this study to determine the utility of the posterior segment OCT as a part of the routine preoperative evaluation of a patient scheduled for cataract surgery to aid the detection of asymptomatic retinal pathology, how well it complements clinical fundus evaluation, and how it influences prognostication of cataract surgery as well as choice of surgical strategy, including intraocular lens (IOL) implantation.

METHODS

THIS WAS A PROSPECTIVE, INTERVENTIONAL CASE SERIES OF patients scheduled for cataract surgery, carried out at the Ila Devi Cataract and Visakha Eye Centre (clinical practice), Ahmedabad, India from April 1, 2017 to January 31, 2018. This study was approved by the hospital ethics committee (ethics committee of the Iladevi Cataract and Visakha Eye Centre) and adhered to the tenets of the Declaration of Helsinki. Informed consent about possible use of data for analysis and research was obtained from patients at the time of inclusion. For inclusion, patients were required to be >18 years old and have (1) cataract of sufficient grade to warrant surgery (as determined through symptoms, LOCS III classification, macular function tests, and correlation between visual acuity and degree of cataract), (2) uneventful surgery, (3) a 3-month follow-up postoperatively, and (4) no concurrent ocular disorder that would affect the decision to undergo cataract surgery or affect/confound the outcomes. One eye of each patient was included for analysis. All grades of nuclear sclerosis (LOCS III classification), with or without posterior subcapsular cataract, were included. Patients with ocular comorbidities such as glaucoma, retinal disease, diabetic or hypertensive retinopathy, uveitis optic neuropathy, or history of previous ocular surgery were excluded.

The preoperative evaluation consisted of the corrected distance visual acuity (CDVA), intraocular pressure as measured by Goldmann applanation tonometry, a complete anterior segment evaluation, binocular indirect ophthalmoscopy and optical biometry, and macular function tests. An experienced retinal surgeon carried out macular evaluation using 90 D biomicroscopy. All eyes underwent color fundus photography (Carl Zeiss, Jena, Germany). All eyes were subject to a 5-line macular HD-raster scan on the spectral-domain Cirrus OCT (Carl Zeiss), both pre- and postoperatively. Experienced vitreoretinal surgeons (D.B. and P.V.) interpreted the OCT scans, which included analysis of the vitreoretinal interface, retina, retinal pigment epithelium, and choroid. Based on binocular indirect, 90 D biomicroscopy, and fundus photography, clinically the macula was classified as "normal" or "abnormal." OCT scans were also classified into "normal" or "abnormal."

TABLE 1. Preoperative Demographics and Distribution of Systemic Comorbidities in the Study Population

Category	Result
Age (median ± SD), years	62.24 ± 4.43
Male: female ratio	684 : 760
Distribution of cataract grade and type (LOCS III), n eyes	
NO,NC II	502
NO,NC III	341
NO,NC IV	118
NO,NC V	3
Posterior subcapsular	140
Cortical cataract + nuclear sclerosis	193
Cortical cataract + nuclear sclerosis + posterior subcapsular	121
Posterior polar	26
Systemic comorbidities, n patients	
Hypertension	189
Diabetes mellitus type II	148
Dyslipidemia	132
Arthritis	89
Congestive cardiac failure	31
Diabetes mellitus type II + hypertension	72
Diabetes mellitus type II + dyslipidemia	76
Hypertension + dyslipidemia	102
Diabetes mellitus type II + hypertension + dyslipidemia	87

NO = nuclear color; NC = nuclear opalesence.

The primary outcome measure was the determination of the incidence of asymptomatic retinal lesions detected on OCT examination in clinically "normal" maculas. Secondary outcome measures included documentation of the change in CDVA and the change in OCT thickness postoperatively.

• **STATISTICAL ANALYSIS:** Descriptive statistics consisted of analysis in terms of absolute numbers and proportions. The repeated-measures analysis of variance (ANOVA) test was used to determine the significance of change in CDVA from baseline to the first and third postoperative months. Likewise, the repeated-measures ANOVA test was used to determine the change in OCT central subfield thickness (CST) postoperatively from baseline as seen at months 1 and 3. The extent of agreement between clinical fundus evaluation and OCT was derived.

RESULTS

ONE THOUSAND FIVE HUNDRED AND THIRTY-NINE EYES (1539 patients) were eligible for the study. Of these,

TABLE 2. Asymptomatic Lesions Detected on Optical Coherence Tomography Scans With a Diagnosis of "Normal Fundus Examination"

	Number of Eyes
Clinically "normal" + OCT scan "normal"	1311
Clinically "normal" + OCT scan "abnormal"	
Epiretinal membrane	53
Vitreomacular traction	35
Retinal pigment epithelium detachment	26
Lamellar macular hole	6
Foveal attenuation (thinning)	5
Cystoid macular edema (intermediate uveitis)	4
Parafoveal telengiectasia	3
Subclinical diabetic macular edema	1

OCT = optical coherence tomography.

reliable OCT scans could not be captured in 75 (4.87%) eyes. Additionally, 20 eyes were found to have a clinically "abnormal" fundus examination, a suspicion that was refuted subsequently on OCT examination. These eyes were also excluded from the analysis. Accordingly, the final analysis included 1444 eyes. The median age was 62.24 years (standard deviation 4.43 years; range 48-87 years). The preoperative demographic profile, systemic health profile, and distribution of type and grade of cataract are detailed in Table 1. Table 2 lists the number of patients in each group based on OCT findings (ie, those with a normal clinical examination and a normal OCT scan and those with a "normal" fundus examination and a retinal diagnosis on OCT).

The median preoperative CDVA was 0.45 ± 0.13 logMAR (range 0.2–1.0 logMAR). The median postoperative CDVA was 0.08 ± 0.05 logMAR (range 0.0–0.18 logMAR) at 1 month. This median improvement in CDVA was maintained until the end of the follow-up period (median CDVA at 3 months was 0.06 ± 0.08 logMAR; range 0.0–0.13 logMAR). The difference was statistically significant (repeated-measures ANOVA test; $P = .015$).

Media opacities precluded meaningful OCT scans in 75 eyes (4.87%). Of the 1444 eyes wherein good-quality OCT scans were obtained, the median preoperative CST was 223.34 ± 21.1 μm (range 187-278 μm). The postoperative median CST was 260.25 ± 39.1 μm (range 204-298 μm) at 1 month and 249.12 ± 19.24 μm (range 204-288 μm) at 3 months. The difference was statistically insignificant (repeated-measures ANOVA $P = .19$). In 1331 eyes, clinical examination of the macula correlated with OCT findings. Of these, in 1311 eyes, with a clinical diagnosis of a "normal macula," OCT also revealed a normal macula.

The incidence of asymptomatic retinal lesions detected on OCT, with a clinical diagnosis of a clinically "normal" macula, is reported in Table 2. Binocular indirect or 90 D ophthalmoscopy (supplemented with fundus photography) failed to detect certain asymptomatic lesions in a certain proportion of eyes (the presence of abnormalities was confirmed on OCT subsequently). Epiretinal membrane (ERM; Figure 1, Left and Right) was the most commonly identified lesion, followed by vitreomacular traction (VMT; Figure 2, Left and Right), retinal pigment epithelial detachment, lamellar macular hole (LMH), foveal attenuation/thinning (Figure 3, Left and Right), cystoid macular edema (CME), parafoveal telengiectasia, and subclinical diabetic macular edema. Counseling for cataract took these findings into account, and patients were explained about the possibility of a guarded visual outcome as well as discouraged from opting for multifocal IOLs. A subset analysis of this group demonstrated an improvement in the median preoperative CDVA from 0.52 ± 0.16 logMAR (range 0.3–1.0 logMAR) to 0.14 ± 0.1 logMAR (range 0.0–0.25 logMAR). The difference between the preoperative and postoperative CDVA was significant ($P = .01$). However, there was no significant difference between the postoperative CDVA of this subset of patients as compared to the rest of the patients ($P = .12$). Whereas 23 patients with asymptomatic retinal lesions had a CDVA worse than 20/25, none of the patients with asymptomatic lesions manifested a visual acuity worse than 20/40. One patient with vitreomacular traction (VMT) demonstrated some degree of anatomic worsening of VMT 2 months after the cataract surgery, without any functional decline in vision. One patient with diabetes mellitus type II was found to have subclinical diabetic macular edema. He was counseled against multifocal lens implantation and received intravitreal therapy before being posted for cataract surgery. A similar approach was adopted for patients with clinically quiescent intermediate uveitis who were found to have subclinical cystoid macular edema on OCT analysis.

Four patients who had a "normal" macula both clinically and on OCT analysis developed Irvine-Gass syndrome a median of 6 weeks after surgery. This was treated with topical nonsteroidal anti-inflammatory drugs and steroids. The extent of agreement between BIO/slit-lamp biomicroscopy/fundus photography and OCT analysis was high: 90.79% (95% confidence interval: 79.40%–94.32%; $P = .011$). Nevertheless, the use of OCT analysis as a routine preoperative measure revealed asymptomatic abnormalities in 9.21% of eyes.

DISCUSSION

OUR STUDY DEMONSTRATES SOME DEGREE OF ENHANCED diagnostic ability and meaningful preoperative analysis of comorbid retinal conditions courtesy of the use of OCT analysis to supplement clinical examination of the retina with BIO and +90 D examination. The importance of

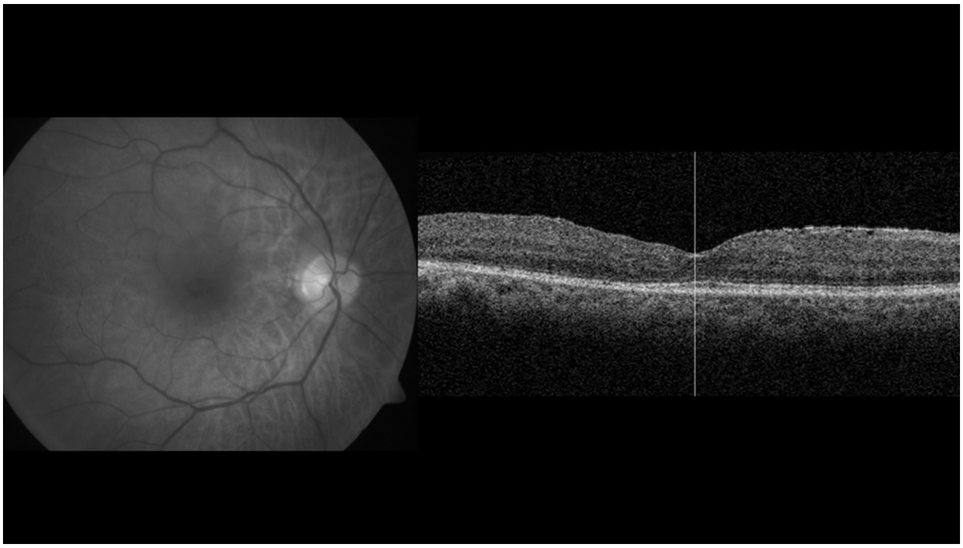

FIGURE 1. (Left) Fundus photograph of a "normal"-looking macula. (Right) Optical coherence tomography scan of the same eye shows mild epiretinal membrane.

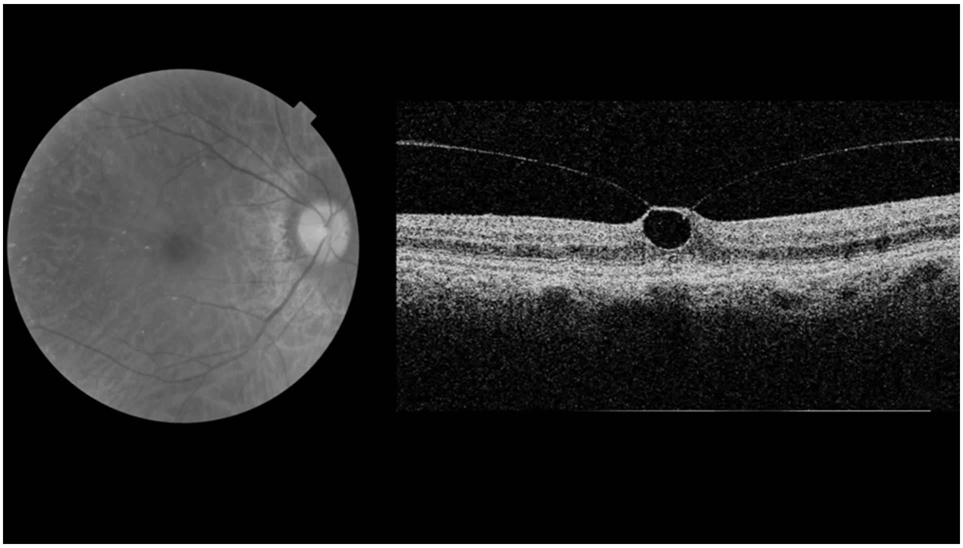

FIGURE 2. (Left) The fundus photograph does not reveal gross macular pathology. (Right) The optical coherence tomography scan of the same eye shows vitreomacular traction.

binocular indirect ophthalmoscopy as a part of routine ophthalmic examination has been dealt with earlier.[6] As stated previously, 9.21% (133 of 1444 eyes) of the eyes scheduled for cataract surgery were found to have subclinical changes on OCT that influenced either the choice of lens or the choice of concurrent therapy.

Klein and associates[4] reported a consecutive case series of 265 eyes that were evaluated for possible multifocal and toric IOL implantation. In this study, in eyes with no clinically detectable macular pathology, occult macular pathology was found on preoperative spectral-domain retinal OCT in 13% of eyes, the common pathologies being age-related macular degeneration (6%), epiretinal membrane (4%), ischemia secondary to previously undiagnosed retinal vascular pathology (2%), and edema (1%). These findings are not unlike ours. Other researchers[5,13] have evaluated the usefulness of swept-source OCT–based biometers for macular disease detection. A retrospective study done in a Chinese population undergoing cataract surgery[14] also found a 25% rate of macular abnormalities detected on OCT. However, this study did not exclude patients with preoperative retinal pathologies. In general, most opinions concur on the importance of preoperative macular assessment in patients undergoing cataract surgery.

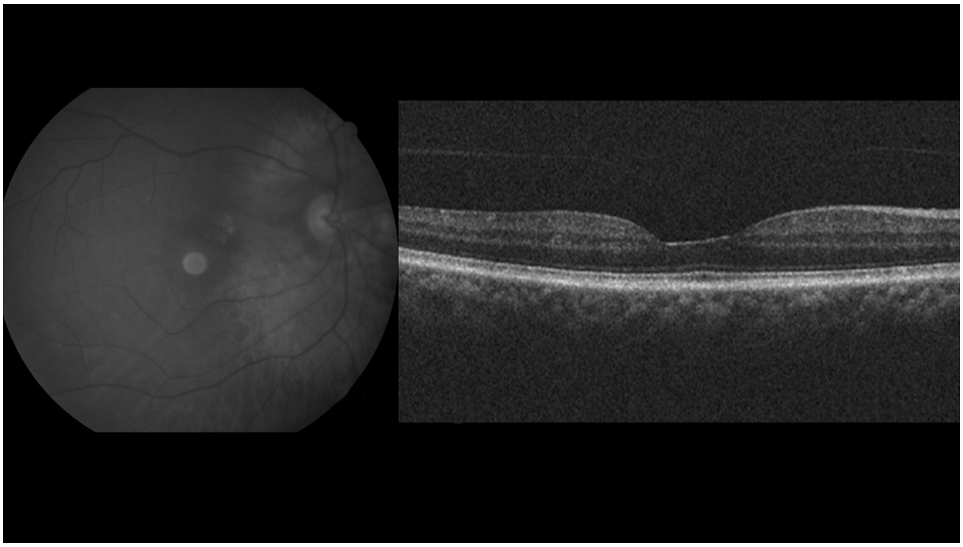

FIGURE 3. (Left) Fundus photograph of a myopic eye; there is no gross macular pathology seen. (Right) Optical coherence tomography shows some flattening of the foveal contour and foveal thinning.

The preoperative detection of asymptomatic lesions on OCT analysis may assume significance when "advanced-technology" IOL implantation (such as multifocal IOL) is being considered. In a population-based study, the Beaver Dam Eye Study group[7] screened 2980 eyes of individuals aged 63-102 years with spectral-domain OCT, the principal objective being to find out the epidemiology of vitreoretinal interface abnormalities in the aging population. Courtesy of SD-OCT, the prevalence of ERMs (34.1%), VMT (1.6%), macular cysts (5.6%), paravascular cysts (PVCs) (20.0%), LMHs (3.6%), and full-thickness macular holes (FTMHs) (0.4%) was estimated. They also reported that the prevalence of macular cysts, ERMs, and VMT increased with age, the prevalence of PVCs decreased with age, and the prevalence of LMHs was not associated with age.

Rapid advances in the preoperative evaluation of cataract patients and cataract surgical techniques have enabled precision and accuracy in terms of the desired postoperative visual results. This has, in turn, raised the bar both for patients and for their treating ophthalmologists. Ocular comorbidities such as glaucoma or retinal disease can compromise visual outcomes. The current generation of ophthalmologists strives hard to avoid such mishaps, and it follows that they are heavily dependent on technology in doing so. The use of OCT can be argued to have enabled ophthalmologists to make the correct decision as to the choice of lens as well as temper patient expectations of postoperative vision. With systemic conditions such as diabetes mellitus on the upswing, it is only natural that ocular comorbidities need to be both diagnosed and treated to achieve a satisfactory visual outcome.

We performed fundus photography and OCT analysis in all patients in this study as part of the presurgical evaluation for cataract. Preoperative testing to detect occult macular pathology prior to cataract surgery has been explored.[5,13–16] It is, however, important to note that patients with asymptomatic lesions as detected on OCT in our series did not have a significantly worse visual outcome, at least in the short term. Also, less than 10% of patients in our series had asymptomatic lesions. Functional tests that attempt to measure visual potential like corrected visual acuity, potential acuity meter measurements, and laser interferometry, in addition to a significant impairment in an individual's performance of daily activities, still remain the most widely used criteria for justifying cataract surgery and for estimating the potential benefit postoperatively. Fundus photography is a supplement to clinical evaluation and helps in documentation, although it is obviously not mandated in routine cases. Newer investigations, like OCT, provide a detailed, complementary structural analysis of the macula. The flipside of added investigations is the added expenditure and expertise of interpretation. Therefore, incorporating them as a routine practice for cataract preoperative evaluation may not be justified yet.

The wealth of information that can be obtained with fundus photography and OCT scans would seem at first sight to outweigh the disadvantages. However, one may end up giving undue emphasis to a seemingly asymptomatic lesion (eg, epiretinal membrane) that may have continued to be asymptomatic postoperatively and may not have influenced visual recovery. It would at this point in time be speculation as to whether the patient could have opted for a "premium" IOL, particularly multifocal IOLs, without compromising visual quality. The concern with multifocal IOLs is that the IOL itself may cause reduction in contrast sensitivity and compound the contrast loss that a pre-existing retinal condition may cause. Overall, not choosing multifocal IOLs might seem a safer option in patients who may go on to develop macular edema consequent to the epiretinal membrane or lead to suboptimal visual acuity and contrast sensitivity. Patients being considered for multifocal IOLs should, in general, receive an OCT scan, as the detection of subtle macular pathology may aid in the counseling process.

The prospective nature of the study and the large sample size therein are its main strengths. The study is obviously limited by the short postoperative follow-up. It would be worthwhile to evaluate the long-term impact of "asymptomatic" macular lesions on postoperative visual outcomes in future studies. Another meaningful approach might be to order OCT scans (in conjunction with fundus photography) for all suspicious lesions, for cases with poor correlation between cataract density and visual loss and for all cases where a multifocal IOL is a possibility, and then compare these data to patients who were considered normal through clinical examination, fundus photographic documentation, and OCT analysis and determine the significance of OCT analysis therein. Cost-benefit analysis can be integrated into future studies as well. Fundus photography similarly allows a more detailed evaluation of the fundus in the aforementioned case scenarios (such as in patients with suspicious lesions and poor correlation between visual loss and cataract density) through the use of various tools such as magnification and various color filters. One can thus indirectly conclude that clinical evaluation remains the mainstay of detection of significant macular lesions in cataract patients undergoing preoperative evaluation.

Thus, to conclude, the incorporation of preoperative OCT as a routine (especially when cost is an issue) may not be justified in all patients, given that the incidence of asymptomatic lesions in our series was less than 10% and that they do not seem to significantly influence postoperative visual acuity in the short term. Additionally, in many instances undue importance may be attached to lesions that would not normally have progressed enough to negatively influence postoperative visual acuity. The use of preoperative OCT may be appropriate in patients being considered for multifocal IOL implantation, as the discovery of subtle abnormalities can be useful for preoperative counseling.

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