Macular Optical Coherence Tomography before Cataract Surgery

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Abstract

Purpose: To determine the benefits of performing preoperative spectral domain optical coherence tomography (SD-OCT) and to identify occult macular pathologies in patients scheduled for routine cataract surgery.

Methods: In this cross-sectional study, macular SD-OCT scans were performed on all patients with clinically undetected macular abnormalities who were scheduled for cataract surgery. Patients with clinically evident macular abnormalities were excluded from the study. A retinal specialist reviewed all the scans. The severity of the cataract was determined using the Oxford Clinical Cataract Classification and Grading System.

Results: Of the 598 evaluated cases, 33 patients (5.52%) had an occult macular abnormality. The most common pathology found in these patients was idiopathic epiretinal membrane, which was detected in 17 eyes (51.52%), followed by vitreomacular traction in nine eyes (27.27%), and dry age-related macular degeneration in four eyes (12.12%). Full-thickness macular holes and a lamellar macular hole were found in two patients (6.06%) and one patient (3.03%), respectively. The frequency of cortical cataracts was significantly lower in patients without macular lesions ($P = 0.012$) than in those with macular lesions. Multivariate logistic regression analysis revealed that age >70 years ($P = 0.025$ and odds ratio [OR] =11.12), smoking history ($P = 0.043$ and OR = 3.43), and hypertension were independently associated with occult macular lesions. The surgical plan was changed for five patients (0.83%).

Conclusions: Macular SD-OCT can be used to detect occult macular lesions and provide useful information about a macula before cataract surgery. Although preoperative OCT found macular abnormalities in about 5% of patients with presumed normal fundus examination, it can result in changing the surgical plan in 0.83% of all patients.

Keywords: Cataract surgery, Occult macular disease, Optical coherence tomography

Introduction

Age-related cataracts are among the leading causes of vision impairments in the elderly.[1] Although cataract surgery is often effective in restoring vision, a significant number of patients with cataracts display ocular comorbidities including macula and optic nerve abnormalities.[2] A comprehensive ocular examination that includes a dilated fundus examination is standard procedure for all patients before cataract surgery to prevent unexpected postoperative visual impairments.

However, subtle macular lesions, especially those found in the presence of significant opacities of the lens, might not be detected during a standard fundus examination. Optical coherence tomography (OCT) is a safe, rapid, noninvasive, and reproducible imaging modality used for structural evaluations of maculae. This procedure allows for a detailed cross-sectional assessment of the macular region even in the presence of media opacity. Spectral-domain OCT (SD-OCT) is the gold standard for diagnosing many macular abnormalities, including vitreomacular interface disorders.[3-6] However, many clinics

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do not routinely perform preoperative macular OCTs before cataract surgery unless macular findings were observed during a standard examination.[5]

It remains unknown whether OCT imaging affects the treatment plans of most patients or whether it needs to be performed for all patients. Thus, the aims of this study were as follows: to determine the role that routinely performed preoperative macular OCT plays in the diagnosis of clinically undetected macular abnormalities in cataract surgery candidates, to assess the factors that are associated with occult macular pathology, and to evaluate the effect that detecting occult macular lesions has on patients' surgical plans or withdrawal from cataract surgery. Accordingly, we wanted to answer the following question: "Should SD-OCT be routinely performed before cataract surgery—if not, which patients should receive it?"

METHODS

Candidates for cataract surgery who were referred to Amiralmomenin Hospital, Rasht, Iran, between April 2018 and March 2020 were enrolled in this cross-sectional study. The present study adhered to the tenets of the Declaration of Helsinki and was approved by the research Ethics Committee of Guilan University of Medical Sciences (code: 1397.115). After the design and objectives of the study were explained to eligible participants, they read and signed the written informed consent sheet. The study sample comprised 597 patients, which was based on the 10.9% prevalence of undiagnosed macular disease reported by Zafar *et al.*[7] A confidence interval (CI) of 95% was considered.

All patients were 15–90 years old and were referred to our anterior segment clinic to undergo cataract surgery. Patients were excluded if they had been diagnosed with macular lesions based on clinical examinations (whether atrophic, cystic, or destructive changes), experienced age-related macular degeneration (AMD) or macular traction or hole, were 15 years old or younger, had a history of diabetic retinopathy or vitreoretinal surgery, were unable to prepare macular SD-OCT due to media opacity, or lacked patient cooperation.

One anterior segment surgeon (M.A.) evaluated all eligible patients. The surgeon performed a complete ocular examination that included slit-lamp biomicroscopy, Goldmann applanation tonometry, and a dilated fundus examination of the macula and peripheral retina using a 90 diopter lens and a Pan Retinal 2.2 lens, respectively. The type and degree of cataract were recorded for all patients. The type of cataract was recorded as either a posterior subcapsular cataract, nuclear sclerotic cataract, or cortical cataract (CC). The degree of cataract was recorded following the Oxford Clinical Cataract Classification and Grading System.[8]

In patients with no clinically evident macular abnormalities, a macular SD-OCT utilizing the Spectralis device (Heidelberg Engineering GmbH, Heidelberg, Germany) was taken in a 9 mm high-resolution horizontal and a vertical line scan passing through the center of the fovea (line scan protocol), as well as a 6 mm × 6 mm volume scan-protocol consisting of 25 lines centered on the fovea. If the 6 mm × 6 mm volume scan detected any abnormality in the parafoveal area, then the area was reevaluated with a high-resolution 9 mm horizontal and vertical scan.

An anterior segment fellowship performed all preoperative examinations during this project. However, in suspicious cases, a preoperative posterior segment consultation was done, and the consultant's opinion was considered for the inclusion or exclusion of case. The patient was excluded from the study if detectable lesion in the macula was confirmed.

A vitreoretinal subspecialist (Y.A.) reviewed all SD-OCT scans for any possible macular pathology. If a scan revealed no abnormal macular findings, the patient was scheduled for phacoemulsification surgery. Patients who had abnormal macular results and needed simultaneous vitreoretinal intervention were given the necessary explanations. Patients who had abnormal macular findings and did not require vitreoretinal intervention were given a full explanation of their visual prognosis after the operation because the abnormalities could have adversely affected their vision after cataract surgery. The appropriate surgery was performed after the patient accepted and signed the revised informed consent based on the OCT findings.

The following information was collected for each patient: age, sex, history of diabetes mellitus (DM), hypertension (HTN), smoking (packs/year), and the serum levels of fasting blood sugar and cholesterol. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured the day before surgery.

Diabetes was defined as fasting blood sugar ≥126 mg/dl or glycosylated hemoglobin ≥6.5%, plasma glucose levels ≥200 mg/dl 2 h after testing with 75 g oral glucose, or random plasma glucose levels ≥200 mg/dl in patients with classic symptoms of hyperglycemia such as polyphagia, polyuria, and polydipsia. Diagnoses were subsequently confirmed by repeating the tests on another day. Moreover, HTN in adults, it was defined as SBP ≥140 mmHg and DBP ≥90 mmHg in more than two measurement settings during two separate office visits. In this respect, hypercholesterolemia was delineated as plasma cholesterol levels ≥240 mg/dl. The values of 200–239 mg/dl were also called borderline.

Statistical analysis

The descriptive results were given as frequencies (%) within a 95% CI. The Chi-square test and Fisher's exact test were used to compare the frequency of occult macular diseases with the clinical variables. The odds ratio (OR) was reported where possible. The numeric variables were described as means ± standard deviation (SD) and were compared between patients with and without occult macular disease using the independent *t*-test. The Mann–Whitney U-test was used when the data did not have a normal distribution. Multivariate logistic regression was used to determine the factors associated

with undetected macular diseases. $P <0.05$ were considered statistically significant. The collected data were statistically analyzed using IBM SPSS Statistics software for Windows Version 21.0 (IBM Corp., Armonk, NY, USA).

RESULTS

This study included 598 patients (336 females [56%] and 262 males [44%]). One eye from each patient was studied. The mean ± SD age of the patients was 65.81 years ± 9.76 years. Among all cases, 46 (7.69%) were smokers (37.65 packs/year ± 14.08 packs; 20–100 packs/year). Only 33 patients (5.52%) had occult macular diseases (95% CI: 3.90–7.57). The prevalence of occult macular diseases was not statistically different between males and females ($P = 0.845$). The demographic and clinical characteristics of the patients with and without macular diseases are shown in Table 1 and Figure 1. Patients with and without macular abnormalities presented statistically significant differences in terms of age, HTN, mean SBP, and mean DBP [$P < 0.05$; Table 1].

The patients were divided into three groups based on their ages: <60 years old (24.6%), 61–70 years old (39.6%), and >70 years old (35.8%). One patient in the <60-year-old group had an occult macular disease, whereas 8 and 24 patients in the 60–70 group and the >70-year-old group had occult macular diseases, respectively [$P < 0.001$; Table 1].

Frequencies of the type and degree of cataracts are shown in Table 2. As indicated in the table, the frequency of CC was the only variable that differed between patients with and without occult macular diseases ($P = 0.012$ and $P > 0.05$, respectively). In other words, the frequency of CCs was significantly lower in patients without occult macular lesions than among other patients ($P = 0.012$).

There were 33 cases of occult macular lesions from the 598 patients assessed, and the most common pathology was epiretinal membranes (ERM). The frequency of ERM was 17 cases (51.52%) (95% CI: 34.94–67.84). The frequency of vitreomacular traction (VMT) was nine cases (27.27%) (95% CI: 14.44–43.90). The frequency of dry AMD was four cases (12.12%) (95% CI: 4.23–26.29). The frequency of full-thickness macular holes was two cases (6.06%) (95% CI: 1.28–18.05). Finally, the frequency of lamellar holes was one case (3.03%) (95% CI: 33–13.30).

The surgical plan was changed for five of the 33 patients (15.5%) with an occult macular disease (three cases of VMT with
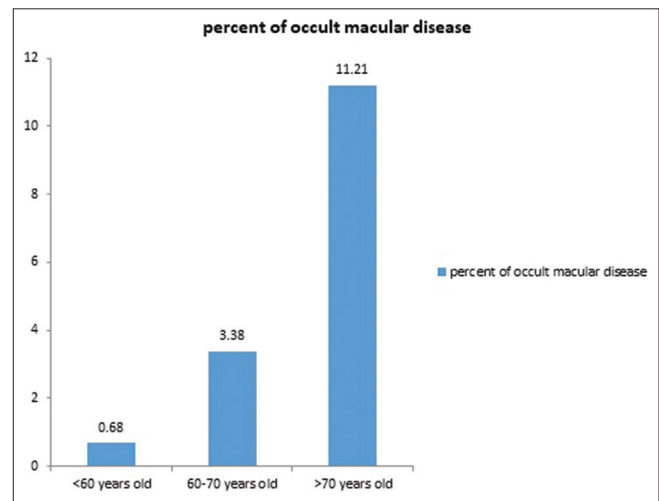

Figure 1: The prevalence of occult macular diseases based on age

Table 1: The demographic and clinical characteristics of the patients in the study					
Variables	**Categories**	**Total, *n* (%)**	**Without macular diseases, *n* (%)**	**With macular diseases, *n* (%)**	**Result**
Gender	Female	336 (56.19)	318 (94.64)	18 (5.36)	0.845*
	Male	262 (43.81)	247 (94.27)	15 (5.73)	
Age (years)	≤60	147 (24.58)	146 (99.32)	1 (0.68)	<0.001*
	61-70	237 (39.63)	229 (96.62)	8 (3.38)	
	>70	214 (35.79)	190 (88.79)	24 (11.21)	
Smoking status	Nonsmoker	552 (92.31)	523 (94.75)	29 (5.25)	0.326†
	Smoker	46 (7.69)	42 (91.30)	4 (8.70)	
HTN	Yes	221 (37.39)	197 (89.14)	24 (10.86)	<0.001*
	No	370 (62.61)	361 (97.57)	9 (2.43)	
DM	Yes	4 (0.68)	3 (75)	1 (25)	0.206†
	No	585 (99.32)	553 (94.53)	32 (5.47)	
Hypercholesterolemia	Yes	1 (0.17)	1 (0.18)	0	0.855†
	Borderline	185 (30.94)	174 (30.80)	11 (33.33)	
	No	412 (68.90)	390 (69.03)	22 (66)	
Serum cholesterol level (mg/dl), mean±SD		191.14±19.26	191.17±19.21	190.48±20.45	0.842‡
SBP (mmHg), mean±SD		121.99±9.82	121.59±9.60	128.82±11.17	<0.001§
DBP (mmHg), mean±SD		77.37±6.33	77.19±6.35	80.30±5.29	0.011§
Fasting blood sugar (mg/dl), mean±SD		86.50±10.55	86.27±10.23	90.58±14.58	0.057§

*Results of the Chi-square test, †Results of Fisher's exact test, ‡Results of the independent *t*-test, §Results of the Mann-Whitney U-test. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SD: Standard deviation, DM: Diabetes mellitus, HTN: Hypertension

Table 2: The frequency of the type and degree of cataracts in patients

Variables	Categories	Total, *n* (%)	Without macular diseases, *n* (%)	With macular diseases, *n* (%)	Result
Nuclear sclerotic cataract	Yes	560 (93.65)	527 (94.11)	33 (5.89)	0.257*
	No	38 (6.35)	38 (100)	0	
Degree of nuclear sclerotic cataract	1	23 (4.11)	-	-	-
	2	63 (11.25)	-	-	
	3-4	474 (84.64)	-	-	
	Mean±SD	2.88±0.58	2.87±0.59	3.03±0.30	0.142†
Posterior subcapsular cataract	Yes	384 (64.21)	364 (94.79)	20 (5.21)	0.656*
	No	214 (35.79)	201 (93.93)	13 (6.07)	
Degree of posterior subcapsular cataract	1	104 (27.08)	-	-	-
	2	128 (33.33)	-	-	
	3	152 (39.58)	-	-	
	Mean±SD	2.13±0.81	2.13±0.82	2.00±0.65	0.395†
Cortical cataract	Yes	103 (17.22)	92 (89.32)	11 (10.68)	0.012*
	No	495 (82.78)	473 (95.56)	22 (4.44)	
Degree of cortical cataract	1	19 (18.45)	-	-	-
	2	63 (61.17)	-	-	
	3	21 (20.39)	-	-	
	Mean±SD	2.02±0.63	2.02±0.65	2.00±0.45	0.902†

*Results of the Chi-square test, †Results of the Mann-Whitney U-test. SD: Standard deviation

increased thickness and two cases of full-thickness macular holes). These five patients represent 0.83% of all patients enrolled in the study. In other cases (including all ERM cases), vitrectomy was not indicated based on the retina specialist's decision. Thus, previously scheduled cataract surgery was performed for these cases.

After all the variables were included in the backward stepwise logistic regression analysis, HTN (P = 0.023 and OR = 2.28), smoking (P = 0.043 and OR = 3.43), and age >70 years (P = 0.025 and OR = 11.12) were found to be independently associated with occult macular lesions. However, CC (P = 0.063) and the age range of 60–70 years old (P = 0.195) were not significantly associated with occult macular diseases.

Discussion

The main objective of the present study was to determine the role that preoperative SD-OCT plays in the diagnosis of clinically undetected macular lesions among cataract surgery candidates. Overall, among patients with normal fundus examination, 5.52% of patients had macular diseases based on SD-OCT. In order of frequency, ERM, VMT, and dry AMD were the most common abnormalities. These findings emphasized the importance of diagnosing patients with macular diseases before cataract surgery. Because undetected macular diseases can impair the visual outcomes of patients after cataract surgery, it is important that they are diagnosed before surgery. However, a clinical ocular examination may fail to diagnose subtle macular diseases. Several studies indicate that some imaging, including OCT, should be performed to accurately diagnose ocular diseases.[3-6]

In the present study, the most common occult macular pathologies were ERM, VMT, and (to a lesser extent) AMD

and macular holes. All ERMs that were detected and defined as an occult macular disease in this study were idiopathic. This is because there was no specific retinal problem or other cause underlying their formation. Furthermore, they were all in the early stages.

The surgical plan was changed for five of the 33 patients (15.5%) with an occult macular disease (three cases of VMT with increased thickness and two cases of full-thickness macular holes). These five patients represent 0.83% of all patients enrolled in the study. In these five cases, the patients were given more information about the possibility of postcataract surgery lower visual acuity and were therefore considered for cataract surgery and pars plana vitrectomy. In other cases (including all ERM cases), vitrectomy was not indicated based on the retina specialist's decision. Thus, previously scheduled cataract surgery was performed for these cases.

Studies have reported that, worldwide, the frequencies of occult macular diseases detected using OCT range from 4.6% to 13.2% (4–6, 9-10). For example, Klein *et al*. performed preoperative macular SD-OCT on 149 patients scheduled for cataract surgery by implanting advanced-technology intraocular lenses. Their findings revealed that 13.2% of patients had occult macular pathology.[6] The most common pathology was AMD (5.66%).

In other research, Moreira Neto *et al*. used SD-OCT to evaluate macular changes in 98 patients before and after cataract surgery. Their results showed that macular pathology was diagnosed using OCT in 10.2% of eyes.[4] Contrary to our study, Moreira Neto *et al*.'s study included patients with diabetic retinopathy. They also found that AMD and ERM were the most common preoperative macular diseases.[4] Huang *et al*. studied 1176 patients scheduled for routine cataract surgery

and found that 10.2% of eyes had clinically undetected macular pathology. The most common macular disorders were ERM and myopic atrophy.[9] Because Huang *et al.* included patients with high myopia, the high rate of macular pathology could be partially related to myopia-associated complications.

In Creese *et al.*'s study on cataract surgery candidates, macular abnormalities were detected by OCT in 10 of 218 eyes (4.6%).[10] This result was similar to the frequency of undiagnosed macular diseases found using OCT in the present study. Possible reasons for the discrepancy between previous studies and the present study regarding the prevalence of occult macular pathology include differences in demographic characteristics, the severity of lens opacity, the inclusion criteria of the study population, and the experience of the examining physician in accurate retinal evaluation. Ethnicity is another potential reason for the discrepancy. In general, our results showed that performing macular OCT before cataract surgery can aid the diagnosis of subclinical macular diseases.

The present study also evaluated the association of demographic properties and undiagnosed macular lesions of cataract surgery candidates. In this study, the mean age of the patients was 65.81 ± 9.76 years. About 75% of the patients were >60 years old. Thus, age is a significant risk factor for cataracts because of the effects of aging on the lens.[11] Age (>70 years) was found to be an important factor related to macular diseases, as it resulted in an 11-fold increase in the risk of occult macular diseases. People >70 years old have a high prevalence of occult macular diseases, which can result in a high prevalence of macular diseases such as AMD and vitreomacular interface disorders.[12,13] Our results align with those presented by other researchers who found that the prevalence of clinically undetected macular lesions was significantly higher in people >70 years of age.[14]

The results of our study also revealed that smoking resulted in a 3.4-fold increase in the risk of developing clinically undiagnosed macular diseases. Previous studies have shown that macular lesions (including AMD and ERM) are associated with smoking, perhaps owing to cell damage induced by smoking.[14-18]

Another important finding of the present study was the higher frequency of HTN and mean levels of SBP and DBP in patients with occult macular pathologies. Our results showed that HTN is a significant risk factor that resulted in a 2.3-fold increase in the risk of occult macular disease. This finding was consistent with the results of previous studies indicating that chronic HTN and antihypertensive medication use are significant risk factors for AMD.[19,20] It has been suggested that this association is related to the roles of the renin–angiotensin system and hemodynamic abnormalities in AMD formation.[21] In the current study, DM was not significantly associated with occult macular lesions. This finding could be due to the small percentage of patients with DM in our study (<1%).

The main strength of the present study was that it investigated a range of variables including the demographic and clinical characteristics of patients, the type and degree of cataracts, and their associations with macular diseases. However, the study also had some limitations. For example, the nonrandomized selection of the study population from one center increased the chances that confounders influenced the results. We tried to overcome this issue by investigating several variables and using logistic regression to control for their effects. Another limitation of this study was the exclusion of patients with any degree of diabetic retinopathy. Typically, surgeons perform macular OCT during preoperative evaluations of patients with cataracts and concomitant diabetic retinopathy, even when clinically apparent macular lesions are not apparent. Therefore, this exclusion may itself be a confounding factor in the results of the study. Another limitation was the cross-sectional nature of the study, which hindered the detection of causal relationships between the variables. Thus, only significant associations between variables were reported. Eventually, the results cannot be generalized as an anterior segment surgeon performed the examinations. If a posterior segment was performed the exams, the normal macula with abnormal OCT might be categorized as abnormal.

Future studies should evaluate the role of SD-OCT in assessing macular changes after cataract surgery. Researchers should also examine its diagnostic value in patients with significant macular diseases, such as diabetic patients.

In conclusion, this study showed that macular SD-OCT can provide valuable information about subtle macular diseases in cataract surgery candidates who might not be clinically diagnosed based on standard ocular examinations. Although preoperative OCT found macular abnormalities in about 5% of patients with presumed normal fundus examination, it can result in changing surgical plan in 0.83% of all patients specially whom with HTN, >70 years old and history of heavy smoking.

Conflicts of interest
There are no conflicts of interest.

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