

Diagnostic imaging in cataract and refractive surgery

Literature review of the clinical role of pre-operative diagnostic imaging



Pre-operative diagnostic imaging in cataract and refractive surgery

Fundus examinations are essential

- Studies show a high prevalence of patients with retinal abnormalities undergoing cataract or refractive surgery.
- Based on a Chinese population study, Huang et al.⁽¹⁾ reported that 25 % of patients considered for routine cataract surgery presented with significant retinal disorders. Klein et al.⁽²⁾ reported numbers as high as 13 % for a private clinic for patients receiving advanced technology IOLs.
- The identification of these ocular abnormalities is of critical importance as these can limit visual outcomes significantly⁽³⁾.
- It is not surprising that the American Academy of Ophthalmology's preferred practice patterns for cataract surgery demand dilated fundus examinations to carefully evaluate the macula, peripheral retina, optic nerve head and vitreous before surgery^(4, 5, 6).

Dilated fundus examinations may miss important pathologies

- Despite being an essential diagnostic procedure, dilated fundus examinations may miss subtle pathologies.
- Several studies have shown that epiretinal membranes and vitreomacular traction are among the most frequently missed pathologies^(1, 2, 7). Although relatively subtle and non-symptomatic before surgery, these changes may significantly limit visual potential after surgery.
- For example, Schaub et al. recently reported that preexisting epiretinal membranes are associated with pseudophakic cystoid macular edema⁽⁸⁾, a condition significantly affecting the visual quality of the patient that necessitates further interventions.

Advanced surgery demands advanced technology

- State-of-the-art diagnostic imaging such as OCT and ultra-widefield fundus imaging has the potential to improve the detectability of retinal abnormalities which are contraindications to cataract or refractive surgery or helps to calibrate patient's expectations for visual function after surgery⁽⁹⁻¹³⁾.
- Both examinations provide ideal complements to dilated fundus examinations for practices and clinics performing cataract or refractive surgery.

Sci Rep. 2018 Mar 23;8(1):5103.

Macular assessment of preoperative optical coherence tomography in ageing Chinese undergoing routine cataract surgery.

Huang X, Zhang Z, Wang J, Meng X, Chen T, Wu Z.

This retrospective consecutive case series aimed to evaluate spectral-domain optical coherence tomography (SD-OCT) for occult macular disease recognition preoperatively in patients scheduled for routine cataract surgery. All patients scheduled for cataract surgery underwent macular SD-OCT. Scans were reviewed for retinal, retinal pigment epithelium and vitreomacular interface abnormalities. For the subgroup analysis, the following information was collected: age; sex; and diabetes, hypertension, myopia, glaucoma, post intra-ocular surgery, endophotocoagulation, retinal vasculopathy and uveitis statuses. One-thousand-one-hundred-seventy-six consecutive scans were acquired from 1,176 patients. Macular pathology was found in 294 eyes. The most common macular disorders were an epiretinal membrane (n=130), myopia atrophy (n=61) and a dome-shaped macular with pathologic myopia (n=32). One-hundred-thirty eyes (11.05%) presented macular epiretinal membranes not detected by dilated fundus examination, accounting for 44.22% of the abnormalities in diseased eyes and was higher than in previous Chinese studies. Some had multiple macular disorders. The most common ocular history was myopia, including high myopia. The pooled prevalence rate of macular diseases detected by OCT was 0.24 (95% CI 0.14-0.34) using meta-analysis. SD-OCT should be performed for routine cataract surgery patients to evaluate visual outcomes, especially in myopic patients and those considering advanced-technology intraocular lenses.

<https://www.ncbi.nlm.nih.gov/pubmed/29572456>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5865193/>

J Cataract Refract Surg. 2016 Apr;42(4):537-41.

Preoperative macular spectral-domain optical coherence tomography in patients considering advanced-technology intraocular lenses for cataract surgery.

Klein BR, Brown EN, Casden RS.

Purpose

To evaluate spectral-domain optical coherence tomography (SD-OCT) as a strategy for identifying occult macular disease preoperatively in patients scheduled for cataract surgery with implantation of an advanced-technology intraocular lens (IOL).

Setting

Private practice, Danbury, Connecticut, USA.

Design

Retrospective consecutive case series.

Methods

Macular SD-OCT scans were performed on all patients scheduled for cataract surgery and Restor multifocal or toric IOL implantation over a 6-month period. All scans were reviewed for abnormalities of the retina, retinal pigment epithelium, or vitreomacular interface. For subgroup analysis, the following health information was collected: age, sex, smoking history, hypertension, heart disease, hyperlipidemia or hypercholesterolemia, and diabetes.

Results

Two hundred sixty-five consecutive scans from 149 patients were obtained. Macular pathology was found in 35 eyes (13.2%). The most common condition was age-related macular degeneration in 15 eyes (5.66%) followed by idiopathic epiretinal membrane in 11 eyes (4.15%). Ischemic atrophy from previously undiagnosed retinal vascular pathology was found in 5 eyes (1.89%) and edema in 3 eyes (1.13%). A subgroup analysis found a higher incidence of macular pathology in patients with a history of heart disease (30.6%, $P < .001$) or smoking (20.2%, $P < .05$), and in men (23.9%, $P < .01$). Media opacities precluded interpretation of 17 scans (6.42%).

Conclusion

Preoperative macular SD-OCT scanning was effective in identifying patients at risk for compromised visual outcomes after advanced-technology IOL surgery.

<https://www.ncbi.nlm.nih.gov/pubmed/27113875>

[http://www.jcrsjournal.org/article/S0886-3350\(16\)00189-9/pdf](http://www.jcrsjournal.org/article/S0886-3350(16)00189-9/pdf)

J Cataract Refract Surg. 2016 Apr;42(4):513-4.

Preoperative screening for occult disease in cataract surgery candidates.

Dupps WJ Jr.

<https://www.ncbi.nlm.nih.gov/pubmed/27113870>

[http://www.jcrsjournal.org/article/S0886-3350\(16\)30017-7/fulltext](http://www.jcrsjournal.org/article/S0886-3350(16)30017-7/fulltext)

Importance of fundoscopy in refractive surgery.

Brady J, O'Keefe M, Kilmartin D.

Purpose

To examine the incidence, treatment, and outcomes of retinal lesions before and after refractive laser surgery.

Setting

Private refractive surgery practice.

Methods

A retrospective review was conducted of patients attending the laser clinic over a 3-year period. Examined were the incidence, type, management, and outcomes of the posterior segment abnormalities encountered.

Results

Fifty two (1.1%) of 4800 patients had posterior segment pathology requiring intervention. Forty-five cases (0.86%) were detected preoperatively and had a mean refraction of -4.5 diopters (D) +/- 3.0 (SD). Seven cases (0.14%) were detected postoperatively at a mean follow-up of 19 +/- 18.3 months; none had preoperative pathology. The mean refraction in this group was -4.4 +/- 2.3 D. Ninety-five percent had myopic prescriptions. All maintained best corrected visual acuity postoperatively. The incidence of retinal detachment was 0.03% per year in the myopic candidates; however, no cases occurred after the refractive procedure.

Conclusion

Dilated fundus examination is an integral part of optimum clinical care in refractive patients, and shared preoperative assessment by a retinal specialist is advisable in those with predisposing retinal pathology.

<https://www.ncbi.nlm.nih.gov/pubmed/17720077>

Curr Opin Ophthalmol. 2017 Jul;28(4):310-315.

Considerations for refractive surgery in the glaucoma patient.

Ahmad M, Chocron I, Shrivastava A.

Purpose of review

Given the popularity of keratorefractive surgery, and an aging populous of patients who have undergone these procedures, there is an increasing need for updated management protocols. This is particularly relevant for patients with chronic progressive diseases such as glaucoma, due to the variety of related diagnostic and management challenges inherent to these diseases. Here, we will review the current literature to provide an update on the management of patients with glaucoma who are undergoing, or have had laser ablative refractive surgery. Preoperative testing and eligibility considerations, intraoperative factors, and postoperative observation and follow-up will be discussed.

Recent findings

Intraoperative intraocular pressure (IOP) rise during flap creation is associated with low risk of acute complications, and furthermore do not appear to have significant long term effects. Modern technologies have improved our ability to determine accurate IOP after refractive surgery despite postoperative changes in corneal architecture. Furthermore, advances in structural imaging allow for earlier detection of even subtle glaucomatous nerve damage.

Summary

Although glaucoma remains a relative contraindication to refractive surgery, it is a safe procedure for many patients with appropriate perioperative management and follow-up. Advancements in diagnostic modalities have allowed for earlier detection of glaucomatous disease, and subsequent earlier intervention when appropriate. Standardized diagnostic algorithms and rigorous perioperative assessment are critical to safe management of glaucoma patients undergoing refractive corneal surgery.

<https://www.ncbi.nlm.nih.gov/pubmed/28445203>

Am J Ophthalmol. 2010 Apr;149(4):641-50.

Observations by spectral-domain optical coherence tomography combined with simultaneous scanning laser ophthalmoscopy: imaging of the vitreous.

Mojana F, Kozak I, Oster SF, Cheng L, Bartsch DU, Brar M, Yuson RM, Freeman WR.

Purpose

To determine the ability to detect normal vitreous structure, evolving posterior vitreous detachment (PVD), and related vitreoretinal changes with combined spectral-domain optical coherence tomography (SD-OCT) and scanning laser ophthalmoscopy (SLO).

Design

Observational cross-sectional study.

Methods

Simultaneous SD-OCT and SLO imaging instruments (SD-OCT/SLO) were used to image both eyes of patients with symptoms of PVD. The vitreous cortex, preretinal lacunae, hyaloid, and its relations to the retinal surface were analyzed. In addition, ultrasound was performed in a subset of patients to determine the stage of PVD.

Results

Two-hundred two eyes of 113 subjects were scanned. There was a high correlation between diagnosis of complete PVD by clinical examination and OCT (95 vs 93 eyes, respectively; kappa, 0.82). A partial PVD was detected more frequently by SD-OCT/SLO than by biomicroscopy examination (45 vs 7 eyes; $P < .0001$). Ultrasound was performed in a subset of 30 eyes. A high agreement was found between ultrasound and SD-OCT/SLO results for both complete PVD (kappa, 0.933) and incomplete PVD (kappa, 0.91). Vitreous cortex was detected in 181 eyes, and posterior precortical vitreous pocket was detected in 85 eyes. The effects of PVD, including vitreoretinal traction, paravascular lamellar holes, and fine changes at the fovea, could be visualized reliably in detail only with SD-OCT/SLO. In all these eyes, SD-OCT/SLO allowed improved visualization of the vitreoretinal relationship.

Conclusions SD-OCT/SLO provides unprecedented in vivo information about the physiologic and pathologic vitreous structure; it allows an extremely detailed analysis of the vitreoretinal interface, and it is particularly useful for defining focal changes and PVD.

<https://www.ncbi.nlm.nih.gov/pubmed/20138610>

Graefes Arch Clin Exp Ophthalmol. 2018 [Epub ahead of print]

Preexisting epiretinal membrane is associated with pseudophakic cystoid macular edema.

Schaub, Adler, Enders, Koenig, Koch, Cursiefen, Kirchhof, Heindl.

Purpose of review

The purpose of the present study was to evaluate whether preexisting epiretinal membrane (ERM) is a significant risk factor for developing pseudophakic cystoid macular edema (PCME).

Methods

Two hundred four consecutive eyes and 153 consecutive eyes without preexisting epiretinal membranes were retrospectively compared regarding PCME development following phacoemulsification with posterior chamber lens implantation. Patients with vascular retinal diseases, uveitis, trauma, neovascular degeneration, chronic inflammatory conditions, diabetic retinopathy, endophthalmitis, eventful cataract surgery, and combination of cataract surgery and vitrectomy during the observation period were excluded. Macular examination was performed using spectral-domain optical coherence tomography (SD-OCT) before as well as at 4, 8, 12, 16, 24, and 36 weeks after cataract surgery. Univariate and multivariate logistic regression analyses were calculated.

Results

PCME occurred in 32 of 204 eyes with preexisting ERM (15.7%), whereas 9 of 153 eyes without preexisting ERM (5.9%) developed PCME. The risk of PCME was significantly increased in eyes with ERM ($p=0.007$). By multivariate logistic regression analysis, factors predictive of PCME included the history of previous pars plana vitrectomy for retinal detachment (odds ratio (OR) 3.619 [95% confidence interval (CI) 1.242 to 10.258]; $p=0.016$) as well as the preexistence of ERM (OR 3.885 [95% CI 1.162 to 17.762]; $p=0.04$).

Conclusion

Preexisting ERM seems to be associated with an increased risk of PCME following cataract surgery. Therefore, this risk should be considered in surgery planning, preoperative medication, and follow-up care after surgery.

<https://www.ncbi.nlm.nih.gov/pubmed/29564551>

Evaluation of the macula prior to cataract surgery.

McKeague M, Sharma P, Ho AC.

Purpose of review

To describe recent evidence regarding methods of evaluation of retinal structure and function prior to cataract surgery.

Recent findings

Studies in patients with cataract but no clinically detectable retinal disease have shown that routine use of optical coherence tomography (OCT) prior to cataract surgery can detect subtle macular disease, which may alter the course of treatment or lead to modification of consent. The routine use of OCT has been especially useful in patients being considered for advanced-technology intraocular lenses (IOLs) as subtle macular disease can be a contraindication to the use of these lenses. The cost-effectiveness of routine use of OCT prior to cataract surgery has not been studied. Other technologies that assess retinal function rather than structure, such as microperimetry and electroretinogram (ERG) need further study to determine whether they can predict retinal potential in cataract patients.

Summary

There is growing evidence for the importance of more detailed retinal evaluation of cataract patients even with clinically normal exam. OCT has been the most established and studied method for retinal evaluation in cataract patients, but other technologies such as microperimetry and ERG are beginning to be studied.

<https://www.ncbi.nlm.nih.gov/pubmed/28902720>

J Cataract Refract Surg. 2016 Apr;42(4):530-6.

Macular disease detection with a swept-source optical coherence tomography-based biometry device in patients scheduled for cataract surgery.

Hirnschall N, Leisser C, Radda S, Maedel S, Findl O

Purpose

To assess the sensitivity and specificity for detecting macular disease with a new optical biometry device with swept-source optical coherence tomography (SS-OCT) used before cataract surgery.

Setting

Hanusch Hospital, Vienna, Austria.

Design

Consecutive case series.

Methods

This study included patients with or without macular disease. All patients were scanned using the new biometry device (IOLMaster 700), which allows a 1.0 mm central retinal scan using SS-OCT technology. Also, all eyes were assessed using a dedicated retinal OCT device (RTVue) on the same day. Two experienced examiners and 1 ophthalmology resident graded all scans individually. Sensitivity and specificity for detecting macular disease were assessed, as were the receiver operating characteristic curves.

Results

Of the 125 eyes included, 5 were excluded from the analysis, 65 had a macular disease, and 55 were healthy. The sensitivity of the biometry device was moderate (between 42% and 68%), and the specificity was high (89% to 98%). Intraobserver reproducibility for assessing the biometry device was 88.3%.

Conclusions

The biometry device with SS-OCT provided useful information concerning the macula, especially for intraretinal fluid and macular holes. However, it cannot replace a macular OCT device.

<https://www.ncbi.nlm.nih.gov/pubmed/27113874>

[http://www.jcrsjournal.org/article/S0886-3350\(16\)30007-4/pdf](http://www.jcrsjournal.org/article/S0886-3350(16)30007-4/pdf)

BMC Ophthalmol. 2017 Dec 15;17(1):250.

The application of wide-field laser ophthalmoscopy in fundus examination before myopic refractive surgery.

Liu L, Wang F, Xu D, Xie C, Zou J.

Background

To evaluate wide-field laser ophthalmoscopy (Optomap 200Tx) for screening retinal lesions before myopic refractive surgery.

Methods

Seventy-eight eyes of 78 consecutive refractive surgery candidates were included in this study. All subjects underwent Optomap 200Tx, mydriatic slit-lamp lens examination and the Goldmann three-mirror contact lens examination, which was considered as the reference method for determining retinal lesions.

Results

Forty of 78 eyes had retinal lesions (51.28%) and three eyes had retinal breaks (3.85%), which were diagnosed by the Goldmann three-mirror contact lens examination. Compared to the Goldmann three-mirror contact lens examination, the detection rate with the Optomap 200Tx was 91.73% for retinal lesions, while the detection rate of mydriatic slit-lamp lens exams was 81.20%. There were no statistically significant differences among the three methods used for the diagnoses of myopic conus, tessellation and retinal breaks (all $p > 0.05$). For peripheral retinal lesions, the detection rate of the Optomap 200Tx examinations were similar to the Goldmann three-mirror contact lens exams (all $p > 0.05$), but were higher than the results of slit-lamp lens examinations (all $p < 0.05$). Regarding the vitreoretinal adhesions, the Goldmann three-mirror contact lens examinations had higher detection rates than did the Optomap 200Tx examinations ($p = 0.031$).

Conclusions

The Optomap 200Tx examinations is a convenient and feasible method to determine fundus pathological changes in myopic patients, especially for patients who can not endure pupil dilation. In order to avoid misdiagnosis of peripheral retinal lesions, Goldmann three-mirror contact lens examination is needed.

<https://www.ncbi.nlm.nih.gov/pubmed/29246204>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5732481/>

Ultra-wide field imaging system and traditional retinal examinations for screening fundus changes after cataract surgery.

Peng J, Zhang Q, Jin HY, Lu WY, Zhao PQ.

Aim

To compare the results of non-mydratic ultra-wide field imaging system, mydratic slit-lamp lens (Volk +90 D) and mydratic Goldmann three-mirror contact lens examinations in screening fundus lesions among patients after cataract surgery.

Methods

Non-mydratic images were obtained with an Optomap panoramic 200Tx (Optomap 200Tx) 3d after surgery and graded by a blinded ophthalmologist. A mydratic slit-lamp lens examination was performed by another blinded retinal specialist on the same day. A third blinded retinal specialist examined patients two weeks after surgery using a Goldmann three-mirror contact lens.

Results

In total, 160 patients (184 eyes) were examined, and 66, 69, and 75 cases of retinal lesion(s) were identified using the Optomap 200Tx, slit-lamp lens, and Goldmann three-mirror contact lens, respectively. In 13 cases, fundus changes were sight-threatening. The results obtained by Optomap 200Tx examination and by mydratic slit-lamp lens examination have good consistency ($P=0.375$, $Kappa=0.942$). The mydratic Goldmann three-mirror lens examination revealed more fundus lesions but are consistent with Optomap 200Tx ($P=0.004$, $Kappa=0.897$) and mydratic slit-lamp lens examination ($P=0.031$, $Kappa=0.932$).

Conclusion

Early post-operative fundus screening in cataract patients is extremely important and necessary to prevent further vision loss. Wide-field imaging is a feasible and convenient tool for fundus examination that can be used as a primary screening method among patients after cataract surgery.

<https://www.ncbi.nlm.nih.gov/pubmed/27672595>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5028665/>

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