THE IMPACT OF OPTICAL COHERENCE TOMOGRAPHY ON SURGICAL DECISION MAKING IN EPIRETINAL MEMBRANE AND VITREOMACULAR TRACTION

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ABSTRACT

Purpose: To compare retinal surgeons' recommendations for management of epiretinal membranes (ERM) and vitreomacular traction syndrome (VMT) based on clinical examination alone, with management based on examination supplemented by optical coherence tomography (OCT).

Methods: A prospective, masked clinical case series was conducted. Surgeons first assessed, on the basis of clinical examination only, whether ERM, VMT, or macular edema was present, questionably present, or absent and made a provisional management recommendation. The retina specialist then reviewed the OCT images, determined the presence or absence of ERM, VMT, or associated macular edema, and made a final management recommendation.

Results: Eighty-four eyes of 73 patients were examined. ERM was identified in 66 (78.6%) of 84 using clinical examination compared to 72 (85.7%) of 84 using OCT ($P = .06$). VMT was identified in five (6%) of 84 using clinical examination compared to 18 (21.4%) of 84 using OCT ($P < .005$). Macular edema was identified in 57 (67.9%) of 84 using clinical examination compared to 70 (83.3%) of 84 using OCT ($P = .003$). Surgical intervention was recommended in 33 cases: 19 (57.6%) based on clinical examination alone and 14 (42.4%) based on the combination of clinical examination and OCT findings.

Conclusions: OCT is more sensitive than clinical examination in detecting ERM, VMT, and associated macular edema. OCT influenced the recommendation for surgical intervention in 42.4% of patients scheduled for surgery.

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INTRODUCTION

Epiretinal membrane (ERM) and vitreomacular traction syndrome (VMT) are two macular disorders that impact central visual acuity. Individuals with ERM or VMT are often referred to retina surgeons for evaluation of whether or not surgical intervention is warranted. The retina surgeon relies primarily on the patient's history and clinical examination to make a surgical recommendation but may also utilize imaging studies, particularly in borderline diagnostic and therapeutic decisions.

Optical coherence tomography (OCT) is a noninvasive imaging technique that has been used increasingly to diagnose and monitor a variety of retinal diseases that affect the macula. OCT has been used to identify ERM, which appears as a hyperreflective layer over the inner retina, and macular edema that may be associated with it.[1] OCT has also been shown to be very helpful in identifying VMT that cannot be identified with clinical examination with slit-lamp biomicroscopy.[2] OCT images of VMT reveal hyperreflective bands representing cortical vitreous and/or cellular membranes extending to the inner retinal surface accompanied by retinal thickening and/or subretinal fluid under the fovea.

Retina specialists frequently use OCT to clarify and quantitate macular pathology in individuals with decreased central acuity. Currently no study, to our knowledge, has evaluated how OCT findings have affected clinicians' recommendations for surgical intervention for patients with these disorders. This report compares retinal surgeons' management of ERM and VMT syndrome based on standard clinical examination with management based on examination supplemented by OCT.

METHODS

This prospective, consecutive, masked clinical case series was approved by The Johns Hopkins Institutional Review Board, and all participating retina specialists gave informed consent before participating in this study. Study participants consisted of a cohort of six attending retina specialists at the Retina Service of the Wilmer Eye Institute, The Johns Hopkins University School of Medicine, who were evaluating patients with macular disorders between June and November 2004. Each retina specialist was invited to participate by one of the study coordinators (D.V.D. or M.C.) if one of those coordinators was present in the clinic to complete and collect the data entry form. A retina specialist could participate multiple times and was included in the study if he or she encountered a patient with macular disorders under study and if the study coordinator was available to identify such patients prior to examination and to monitor the necessary masked collection of data.

Surgeons first assessed, based on the history provided by the patient and clinical examination only (using stereoscopic slit-lamp biomicroscopy with either contact lens, 78-diopter non–contact lens, or 90-diopter non–contact lens after pharmacologic dilation), whether ERM, VMT, and/or macular edema was present, questionably present, or not present and made a provisional management

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recommendation. An experienced OCT technician, masked to the findings on the clinical examination, performed the OCT scanning using the Stratus OCT (OCT 3; Carl Zeiss Meditech Inc, Dublin, California). OCT images were generated using the fast macular scan mode (6 radial lines oriented 30 degrees from one another centered on the fovea) according to the manufacturer's protocol.[3] In addition, individual 5-mm line scans were performed through the fovea (in the horizontal and vertical direction). Foveal thickness measurements were obtained manually by placement of calipers at the vitreous-retina and retina–retinal pigment epithelium interfaces. The treating retina specialist then reviewed all of the OCT images and indicated the presence or absence of ERM, VMT, and associated macular edema. In this study, ERM was defined on OCT as a highly reflective membrane at the vitreomacular interface, and VMT was defined as separation of the posterior hyaloid from the retina in the parafoveal region with adherent vitreous over the fovea causing traction on the underlying retina. In addition, macular edema on OCT was defined as any abnormal thickening of the fovea (with loss or alteration of the foveal contour, and with or without cystic intraretinal spaces). No specific numeric value for retinal thickening was used to define macular edema in order to enable the treating retina specialist to make the definitive diagnosis. Recommendations for surgical intervention based on clinical examination findings only, compared with recommendations based on clinical examination plus OCT findings, were evaluated.

RESULTS

Six retina specialists participated and examined a total of 84 eyes of 73 adult patients. Epiretinal membrane was identified in 66 (78.6%) of 84 eyes using clinical examination compared to 72 (85.7%) of 84 eyes using OCT ($P = .06$, one-sample test of proportion). OCT detected ERM in six (37.5%) of 16 eyes in which ERM was not diagnosed with clinical examination. OCT identified ERM in all cases in which one was found on clinical examination.

A component of VMT was identified in five (6%) of 84 eyes using clinical examination compared to 18 (21.4%) of 84 eyes using OCT ($P < .005$, one-sample test of proportion). OCT detected VMT in nine (12.3%) of 73 eyes in which VMT was not diagnosed with clinical examination, and OCT detected VMT in four (66.7%) of six eyes in which VMT was clinically graded as questionably present.

Macular edema was identified in 57 (67.9%) of 84 eyes using clinical examination compared to 70 (83.3%) of 84 eyes using OCT ($P = .003$). OCT detected macular edema in seven (63.6%) of 11 eyes in which macular edema was not diagnosed with clinical examination, and OCT detected macular edema in six (60%) of 10 eyes in which macular edema was clinically graded as questionably present. Mean foveal thickness was 338 µm in eyes in which macular edema was present on both examination and OCT, 254 µm in eyes in which macular edema was questionably present on examination but definitely present on OCT, and 237 µm in eyes in which macular edema was not present on examination but definitely present on OCT. A summary of the clinical findings compared to the OCT findings is in Figure 1.

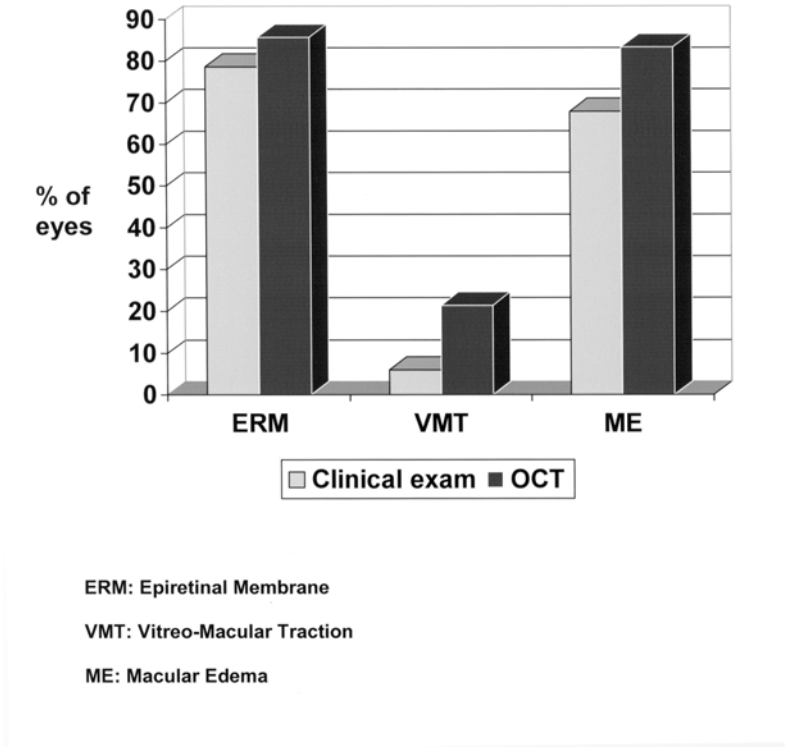

FIGURE 1

Comparison of optical coherence tomography (OCT) and clinical examination in detecting epiretinal membrane (ERM), vitreomacular traction syndrome (VMT), and macular edema (ME) associated with these disorders. OCT is more sensitive. The difference in detection rates was statistically significant for VMT and ME.

Surgical intervention was recommended in 33 eyes: 19 (57.6%) based on clinical examination alone and 14 (42.4%) based on the combination of clinical examination and OCT findings (Table). Of the additional 14 eyes for whom, without the OCT results, careful follow-up alone would have been recommended, seven cases had VMT detected by OCT and not by clinical examination (Figure 2), four cases had ERMs with significant macular edema (mean foveal thickness of 232 µm) detected by OCT but not appreciated clinically, two cases had ERMs detected by OCT and not by clinical examination, and one case had ERM and macular edema diagnosed on both clinical examination and OCT, but the OCT images revealed more extensive edema than originally thought on clinical examination alone (Figure 3).

TABLE. EYES IN WHICH SURGICAL INTERVENTION WAS RECOMMENDED BASED ON CLINICAL EXAMINATION ALONE OR ON CLINICAL EXAMINATION AND OPTICAL COHERENCE TOMOGRAPHY FINDINGS

PROCEDURE	EYES (%)
Clinical examination	19 (57.6)
Clinical examination and OCT	14 (42.4)
Detection of VMT by OCT and not by clinical examination	7
Detection of ME by OCT and not by clinical examination	4
Detection of ERM by OCT and not by clinical examination	2
More extensive ME by OCT than byclinical examination	1

ERM = epiretinal membrane; ME = macular edema; OCT = optical coherence tomography; VMT = vitreomacular traction.

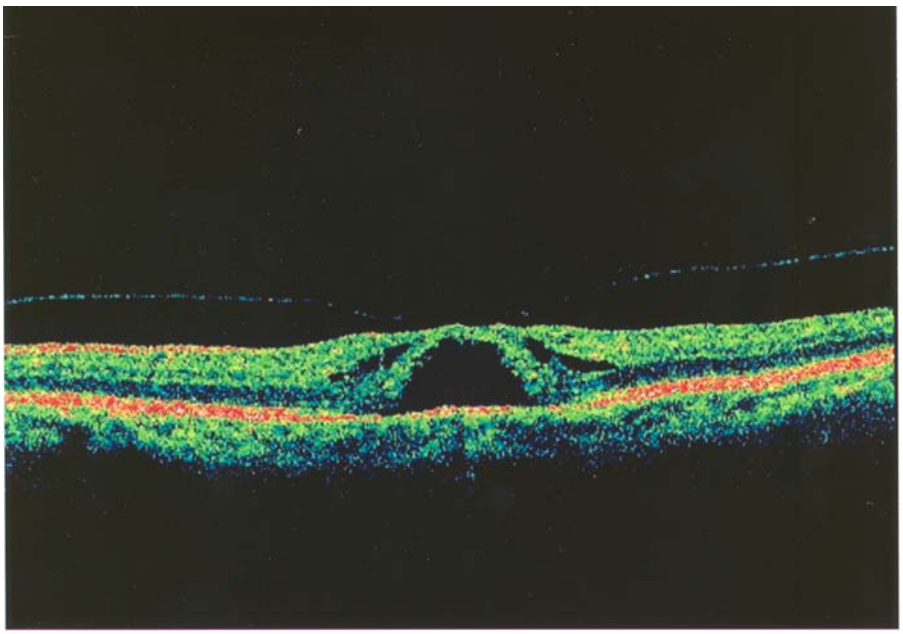

FIGURE 2

An example of a case in which the optical coherence tomogram reveals vitreomacular traction (VMT), which was not detected on clinical examination. The VMT is demonstrated by the presence of hyperreflective bands representing the cortical vitreous extending to the inner retinal surface, resulting in loss of the normal foveal contour, hyporeflective intraretinal cystic spaces, and hyporeflective subretinal fluid underneath the fovea.

A number of factors impacted the surgeons' recommendations. Additional baseline characteristics revealed a median Snellen visual acuity of 20/40 among the 51 eyes not recommended for surgery compared to a median Snellen visual acuity of 20/100 among the 33 eyes recommended for surgery. In addition, the foveal thickness measurement on OCT demonstrated a mean retinal thickness of 275 µm among the cohort not recommended for surgery compared to 348 µm among the cohort recommended for surgery. Additional factors, such as a patient's visual symptoms, are important in the decision-making process for surgical recommendation. Although all patients that were recommended for surgery had some level of symptoms, quantification of symptoms was not performed in this study.

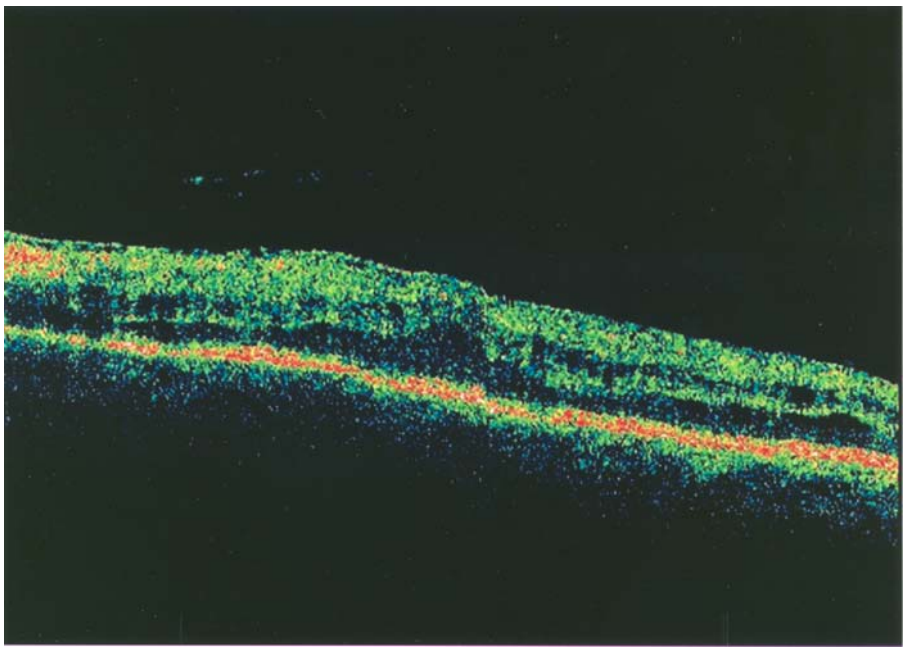

FIGURE 3

An example of a case in which the optical coherence tomogram reveals more extensive macular edema and epiretinal membrane (ERM) than detected on clinical examination. The ERM is seen as a hyperreflective layer overlying the inner retina, resulting in loss of the normal foveal contour and diffuse retinal thickening with areas of hyporeflective cystic spaces.

DISCUSSION

This prospective clinical case series is, to our knowledge, the first reported systematic comparison of the impact of OCT on surgical decision making in ERM and VMT. We compared retinal surgeons' management of these macular disorders with and without the addition of OCT to their clinical examination. We were interested in evaluating whether OCT, obtained more and more commonly in patients with macular disorders, has affected their surgical management.[1]

In this study, OCT was more sensitive than clinical examination in detecting both ERM and VMT, and this difference in detection was statistically significant for VMT. OCT was also more sensitive than clinical examination in detecting macular edema associated with either ERM or VMT. The superior sensitivity of OCT in diagnosing macular edema has previously been reported in eyes with diabetic macular edema.[4,5]

A potential weakness of this study is the lack of uniform protocol for clinical examination of the macula. This does, however, reflect actual clinical practice. Almost all participating surgeons used contact lens examination to evaluate patients because they knew the objectives of this study, and they understood that their ability to detect ERM, VMT, or macular edema was to be compared to detection with OCT. OCT has been shown in other studies to be more sensitive than contact lens biomicroscopy in detecting certain macular pathology.[2,4,5] It is possible that non–contact lens biomicroscopic examinations are even less sensitive at detecting ERM, VMT, and macular edema.

In this study, OCT significantly influenced the recommendation for surgical intervention in patients scheduled for surgery. Among the 33 patients scheduled for surgery, almost half (14 patients) had their surgical intervention recommended after OCT imaging revealed either undetected VMT (seven cases), undetected ERM (two cases), or undetected or more significant macular edema associated with ERM (five cases) that was consistent with their history, visual acuity, and symptoms. OCT was able to detect macular disorders missed or underestimated by clinical examination. Recommendations for surgery were most strongly influenced by the patient's subjective symptoms and ophthalmic examination.

Evaluation of the baseline characteristics of patients recommended for surgery revealed lower levels of visual acuity (median visual acuity of 20/100 in the cohort recommended for surgery compared to median visual acuity of 20/40 in the cohort not recommended for surgery). A patient's level of visual acuity is a key factor in the surgeon's decision to recommend an intervention, and in this series patients with worse acuity were indeed recommended for surgery. However, almost half of the eyes (14 of 33) judged appropriate for surgical intervention would have been advised to defer surgery despite their lower level of vision if the OCT had not been obtained.

Macular edema was more pronounced in patients recommended for surgery (mean retinal thickness of 275 µm among the cohort not recommended to consider surgery compared to 348 µm among the cohort recommended to consider surgery). Although retinal thickness on OCT does not always correlate with visual acuity, macular edema may play an important role in determining if surgery is appropriate to recommend, because greater edema is often associated with lower levels of visual acuity. The presence of a greater amount of macular edema may affect the surgeon's management decision. Among the 14 cases recommended for surgery based on the combination of clinical examination and OCT findings, four cases involved detection of macular edema with ERM by OCT and not by clinical examination. In these four cases, the mean foveal thickness was 232 µm, a value that represents mild retina thickening

according to several published studies.[4,6]

In summary, the data presented in this case series demonstrate that OCT is more sensitive than clinical examination in detecting ERM, VMT, and associated macular edema. OCT was a significant factor affecting the recommendation in almost half of the patients for whom surgery was deemed reasonable. In patients with ERM or suspected VMT, OCT is likely to provide useful information that may affect the clinician's therapeutic recommendations. Further research is necessary to evaluate how these changes in clinical recommendations based on the addition of OCT to surgeons' practice patterns impact surgical outcomes.

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PEER DISCUSSION

DR JOSE S. PULIDO: We all have seen the marked increase of the use of optical coherence tomography (OCT) in clinical practice but quantitative determination of how it has affected our practice is lacking. The authors have performed an interesting study that determined in a semi-consecutive fashion whether OCT determination changed their surgical recommendation for cases of epiretinal membranes (ERM), vitreomacular traction (VMT), or the macular edema associated with these conditions. They found OCT increased the diagnosis of ERM by 10%, VMT by 260% and ME by 23%. In addition, surgical intervention was increased from 19 cases based on clinical examination alone to 33 cases based on clinical examination and OCT which was a 73% increase in surgical intervention.

My concerns about this study are that it was not truly consecutive so this needs to be considered. Which cases were excluded can not be determined. Further, how can their findings be generalized? The authors especially, the corresponding author, are superb clinicians. One can then extrapolate that if it changed and increased the diagnostic acumen in this group then OCT would further increase the diagnostic acumen at least to this level in other groups as well. However, the question that was not answered was whether this increase in diagnosis and in surgical intervention made a clinical difference. For instance, for patients in which the decision for surgery was made following the addition of OCT determination do as well as those who had the decision for surgery based solely on clinical parameters. Did the nonclinical determination by OCT make a clinical difference in outcomes? Finally, did the OCT really increase the clinical decision or could it be that having the OCT decreases the need for clinical acumen and in an age of the need for efficiency and speed, the clinicians have become more reliant on a machine? These questions need to be answered.

DR MARK W. JOHNSON: There is very little question that OCT is more sensitive in detecting these vitreoretinal interface features. But I am a little troubled by the extent to which the OCT findings influenced surgery. This data suggest that surgery is being recommended just because something is there, not so much because the disease is affecting the patient's function. Hopefully, if our surgical decisions are based on the visual acuity and the patient's perception of the visual disability, then the degree of the epiretinal membrane on the OCT, or the amount of macular edema, really should not influence that. I was curious about the extent to which the OCT influenced the decision for surgery.

DR VINOD LAKHANPAL: In my practice, I have noticed that the OCT picture makes such an interesting demonstration to the patient that they better understand their disease or problem. Fundus photos cannot really demonstrate the disease well. If you show them an OCT with vitreomacular traction, 20/25 vision, with little distortion they get a more accurate idea of what is happening. So it is important for the patient and their understanding of the disease process.

DR MYLAN R.VAN NEWKIRK: Was B-scan ultrasonography done on these patients, especially vitreo-macular traction patients?

DR JULIA A. HALLER: Dr. Van Newkirk, we did not do B scans, but your point is well-taken in that this has historically been our best modality for determining extent of PVD and presence or absence of traction, so it would be interesting to try to correlate the sonographic and tomographic images. There is a lot of interest, particularly in some of the clinical trials now, in trying to determine how reliably OCT can pick up vitreomacular traction and to determine better ways of understanding the vitreomacular interface.

I completely agree with Dr Lakhanpal that OCT has tremendous patient education value. The only caveat I would add is that some patients may get more alarmed than necessary when they are shown what look like marked retinal changes on OCT imaging. Some of these diseases are fairly stable, particularly in the case of epiretinal membranes, and we do not recommend surgery, even though we may see some very visible changes on the OCT.

With regard to Dr Johnson's point, in deciding on a clinical recommendation, we were not just looking at the clinical exam or the OCT results. We were also taking into account the patients' symptomatology. The patients that I would previously have advised to just

live with their symptoms, but based on OCT instead offered them surgery were those who were complaining bitterly about their lifestyle compromise, but yet were able to read down to the 20/50 line or so in my office. If the OCT indicated that there was more edema or more traction than I had anticipated clinically, that information combined with the history and exam would encourage me now to consider surgery. Previously I would have not operated, despite the patient's complaints. That is the category of patient where the OCT has made an impact for me.

Dr Pulido makes a number of important and provocative points. In answer to his question, "Are we relying more and more now on machines rather than on our clinical examination?" I think we probably are. And it is not just with regard to macular examinations; it is true to a certain extent throughout medicine, and we as educators have to make sure that the vitally important art of clinical examination is not lost. We have noted, anecdotally, that our first-year fellows come into our program from highly regarded residencies without having uniformly mastered even the fundus contact lens and peripheral retinal examinations. We need to maintain these techniques in our armamentarium and teach them in the training programs. In cardiology, the extensive listening times that trainees used to devote to interpreting heart sounds are now being used to learn interventional techniques. Do neuro-ophthalmologists spend as much time on their tangent screens, now that they have MRI and other types of scanning mechanisms? It is somewhat inevitable that these technological advances are going to impact on the amount of time we put into a clinical exam.

With regard to outcomes, this is an excellent, key point and one that merits further investigation. It will be increasingly important to track final results in order to understand how new technologies which change our clinical behavior actually affect patient outcomes. Are the findings we pick up on OCT that sway us to recommend surgery at an earlier stage really resulting in better long-term visual acuity for our patients? If so, then the technology has really impacted positively on patient care. For the future, certainly the earlier diagnosis of more subtle diseases would be important if we had better ways to treat them. For example, if we had injectable effective vitreolytic enzymes or other in-office approaches that could separate the vitreomacular interface simply and safely, then it would be even more crucial to pick up these diseases at earlier stages. So studies like this one evaluating the way new technology impacts on our clinical practice, and follow-up studies of the final outcome of this impact, will continue to be important as new treatment modalities become available for our patients.