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Intraoperative OCT-assisted chorioretinal biopsy in the DISCOVER study

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Abstract

TOPIC—To assess the role and utility of intraoperative optical coherence tomography (iOCT) guidance during pars plana vitrectomy with chorioretinal biopsy for patients with suspicious chorioretinal lesions.

CLINICAL RELEVANCE—Chorioretinal lesions suspicious for malignancy sometimes require surgical biopsy for diagnosis and treatment guidance. Biopsy site selection is currently guided by presurgical imaging, and clinical assessment. We sought to determine whether iOCT provides useful information for biopsy site selection to ensure a diagnostic specimen and assessment of wound repair after biopsy.

MATERIALS AND METHODS—DISCOVER is a prospective study examining microscope-integrated iOCT systems in ophthalmic surgery. In this report, we examine all eyes in the DISCOVER study that underwent chorioretinal biopsy. Clinical characteristics, surgical technique, and imaging findings were reviewed. In addition, surgeon feedback data on iOCT utility and value to the procedure was also evaluated.

RESULTS—Six eyes were identified within the DISCOVER study that underwent chorioretinal biopsy. iOCT was used to assess retinal and choroidal lesions prior to chorioretinal incision. Following biopsy, iOCT was utilized to assess retinal attachment and wound margin integrity. Additionally, iOCT was performed in real-time during biopsy to ensure proper biopsy depth and position. In 2 cases, preoperative OCT evaluation of retinal lesions was not possible. Utilizing iOCT, comprehensive evaluation of anatomic features was successfully performed prior to biopsy. This facilitated identification of biopsy sites most likely to provide a diagnostic sample based on lesion morphology on iOCT. After completion of chorioretinal biopsy, iOCT verified completeness of biopsy site and the retinal-RPE relationship (e.g., complete apposition, partial detachment).

CONCLUSION—Microscope-integrated iOCT provides real-time guidance of biopsy site selection and verification of biopsy site stability following specimen collection.

Keywords

Introperative OCT; Optical coherence tomography; DISCOVER study; Chorioretinal Biopsy

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Introduction

Infiltrative conditions such as lymphoproliferative disorders, amyloidosis, and autoimmune and infectious disorders can overlap in their ophthalmic clinical presentation. Malignancies and other infiltrative disease processes can masquerade as ocular inflammatory conditions. In order to obtain a definitive clinical diagnosis, a biopsy of the choroid and/or retina may be warranted. When conducting biopsy of intraocular structures, preoperative understanding of retinal microanatomy frequently informs surgical planning. While office based, clinical table-top OCT units have been used for imaging lesions preoperatively, static office-based testing and limited peripheral visualization may diminish the role for utilizing OCT for identification of the optimal biopsy site. The use of intraoperative imaging to assist the clinical decision making during chorioretinal biopsies has not been assessed. Intraoperative OCT (iOCT) has already demonstrated utility in surgical maneuvers including epiretinal membrane delamination, perfluorocarbon liquid removal, subretinal injections for submacular surgery, and interface dynamics in corneal transplantations [1–8].

In this report, we describe the potential role of intraoperative image-guided biopsy in infiltrative chorioretinal diseases and the overall impact of this information on surgical decision-making.

Methods

The DISCOVER study is an IRB-approved single-site, multi-surgeon, prospective consecutive case series assessing the use of microscope-integrated OCT devices in ophthalmic surgery.[9, 10] The study adhered to the tenets of the Declaration of Helsinki. Written informed consent was obtained from all patients participating in the DISCOVER study. During the procedure, imaging was obtained during and/or after surgical milestones, as deemed necessary by the surgeon. Here we report a series of 6 patients undergoing chorioretinal biopsy from April 2014 to April 2016 who were identified for inclusion.

For this analysis, inclusion criteria included patients requiring diagnostic vitrectomy with preoperative plan to perform chorioretinal biopsy for a clinically suspicious chorioretinal lesion. Surgeon impression of iOCT utility (e.g., role for identifying biopsy site, evaluation of completeness of biopsy, assessment of post-biopsy retinal anatomy) utilizing a surgeon feedback questionnaire was evaluated. Preoperative and postoperative clinical characteristics were analyzed including visual acuity, ophthalmic features, and postoperative anatomical/functional outcomes. Images from all cases were independently reviewed for anatomic features and potential role in added value.

In each case, the underlying clinical course, diagnostic features, and preoperative imaging had determined the necessity for tissue biopsy to achieve a definitive diagnosis. Surgical procedures involved vitreous biopsy, complete vitrectomy, iOCT assessment of chorioretinal lesion anatomy, planning for chorioretinal biopsy site, collection of the biopsy, and wound tamponade with laser, gas or both. For biopsy collection the site was delimited using endocautery prior to biopsy collection. In cases A and F the biopsy was collected using

direct removal by microvitrectomy with the aspirated sample sent for pathological analysis. Full-thickness retinochoroidal biospsy was collected en bloc in cases B, C, D and F.

Results

The patient demographics, procedural and diagnostic information is summarized in Table 1. The mean age was 68.7 years old with 3 males and 3 females. Five patients presented with vitritis and all 6 patients were noted preoperatively to have a subretinal lesion. Diagnostic vitrectomy with vitreous biopsy was performed in all but one case. In one case (Case E) a subretinal biopsy was deferred based on information from iOCT indicating that the extramacular elements of the lesion was inadequate to justify biopsy in the context of dense vitreous debris collected during vitreous biopsy which was deemed likely to result in diagnosis. Five cases yielded a diagnosis of lymphoma, and a single case concluded with a diagnosis of idiopathic posterior scleritis. Each case is listed in Table 1, documented in Figures 1–3, Supplemental Figures 1–4 and Videos in Supplemental Digital Content 1 and Supplemental Digital Content 2.

Two surgeons employed intraoperative OCT for assistance in 6 cases determined preoperatively to require subretinal lesion biopsy to make a diagnosis. In 100% of cases the surgeon reported that the iOCT provided valuable feedback about biopsy site. In 17%, the iOCT was critical to determining which site to biopsy, in 17% the lack of substantial volume of subretinal material on iOCT precluded a biopsy. Surgeons reported that using the heads-up ocular display in 83% of cases, with preference for the on-screen display in 17% of cases.

Case Samples

Case A—84 year old patient had undergone a previously negative diagnostic vitrectomy and presented with multifocal subretinal pathology. Preoperative SDOCT assessment demonstrated subretinal pathology in one extramacular focus (Supplementary Figure 1), but was unable to capture more peripheral pathology. During the surgical case, iOCT was used to assess each of the peripheral foci to identify the preferred biopsy site based on OCT features (Figure 1, Supplemental Video 1). Biopsy was performed by delineating the biopsy site with thermal cautery, incising the wound margin using pneumatic vertical scissors and chorioretinal biopsy explantation through an enlarged sclerotomy using forceps. Following biopsy, the iOCT provided feedback regarding the anatomic features of the residual large chorioretinal defect. Surgeon impression through the surgical microscope was that the retinectomy edges were flat; however, iOCT demonstrated elevated edges with subretinal fluid (Figure 2a). After fluid-air exchange and laser barricade to the retinectomy edges, iOCT confirmed complete apposition of the retinal tissues (Figure 2b).

Case B—A 52 year old patient presented with a very large subretinal lesion. During subretinal biopsy, iOCT highlighted the microanatomy before, during and after biopsy (Figure 3, Supplemental Video 2). The biopsy site was marked using thermal cautery to achieve hemostasis, and direct vitrector application to retina and subretinal material in the biopsy site was used to liberate and aspirate biopsy material. Absence of fluid at the biopsy wound's margin was confirmed with iOCT after fluid-air exchange (Figure 3f) and the patient's eye was filled with SF6 gas.

Discussion

Diagnostic dilemmas and the need for chorioretinal biopsy in infiltrative chorioretinal diseases are common. Various methods for chorioretinal biopsy and tissue processing have been reported [11]. Although yields from chorioretinal biopsy are high, as many as 25% of cases may yield no diagnosis[12]. Potential sources for challenges during these procedures include identification of optimal biopsy site, obtaining sufficient volume of material, and prevention of secondary complications. In this report, we describe the potential utility of iOCT in guiding surgical decision-making in order to overcome these challenges.

In this report, iOCT provided several important benefits to chorioretinal biopsy procedures. Biopsy site selection is critical to ensure a high diagnostic yield [13]. In this series, iOCT assisted the surgeon in localizing biopsy sites by identifying landmarks and providing details on the relative thickness of subretinal lesions. Additionally, iOCT feedback during the biopsy procedure allowed the surgeon to assess the amount of tissue available for collection to help facilitate an adequate sample of biopsy material. Assessing post-biopsy anatomy is also critical to optimizing maintenance of vision and reducing the risk of postoperative complications. In this series, iOCT was utilized to evaluate biopsy margins and to determine if retinal edges were flat. Although small in sample size, 100 % of lesions biopsied in this series were diagnostic.

Further research in iOCT-guided chorioretinal biopsy is needed to assess its broader utility and value for improving diagnostic yields and improving surgical outcomes. Future enhancements in real-time software analysis, tissue/instrument tracking, and iOCT-friendly instruments may also improve the surgeon's ability to obtain small samples in these cases. In conclusion, this report demonstrates the ability of iOCT to provide microstructural information, which may facilitate biopsy site selection with the goal of optimizing sample acquisition and diagnostic yield.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Summary Statement

Intraoperative OCT (iOCT) is a useful tool to select optimal biopsy site for chorioretinal sample collection and assessing retinal wound repair. In this work we present a series of 6 patients in whom iOCT was demonstrated and found to be usful during surgical biopsy for the diagnosis of infiltrative chorioretinal pathology.

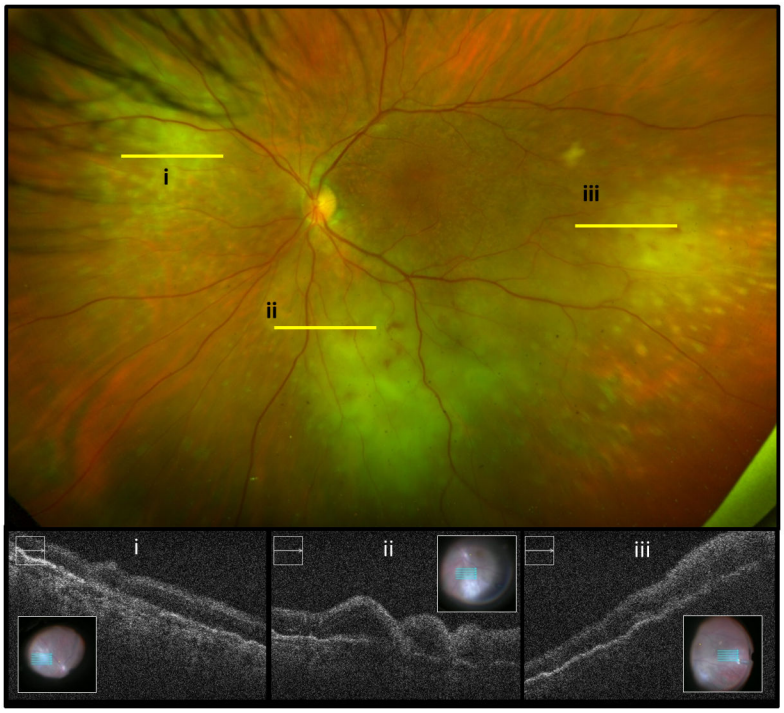

Figure 1.

Case A Intraoperative assessment of multifocal retinal lesions (Optos widefield image is rotated 180 degrees to simulate surgeon's view). iOCT demonstrates sites *ii* having the largest pathological elevation, while sites i and iii have minimal pathology.

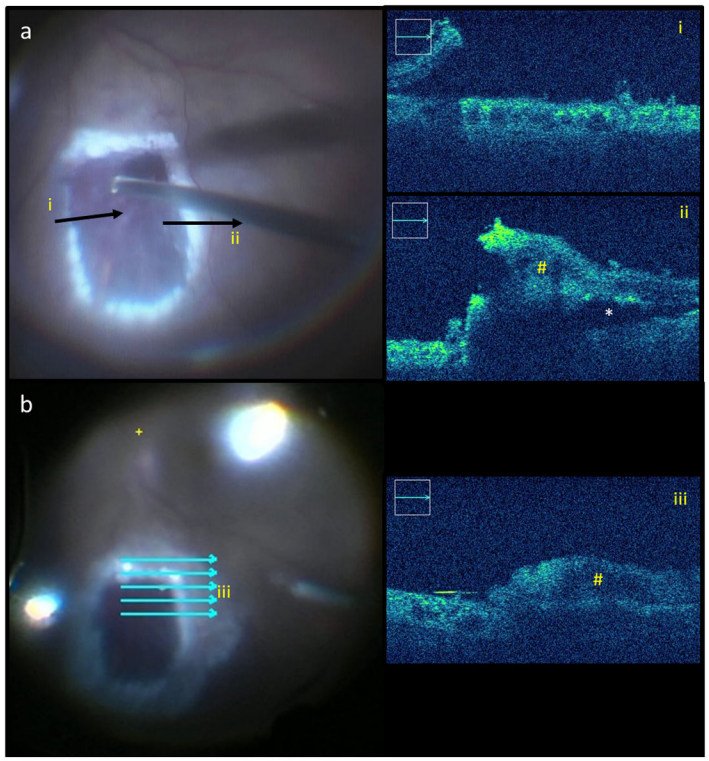

Figure 2.

Case A: iOCT demonstrates incomplete repair of retinectomy wound edges (a) with insets corresponding to iOCT scans (*i* and *ii*). After laser treatement and fluid-air exchange the edges of the retinopexy flatten (b) as demonstrated on inset *iii*. Asterisk represents subretinal fluid, and hash tag intraretinal fluid from cautery and laser scars.

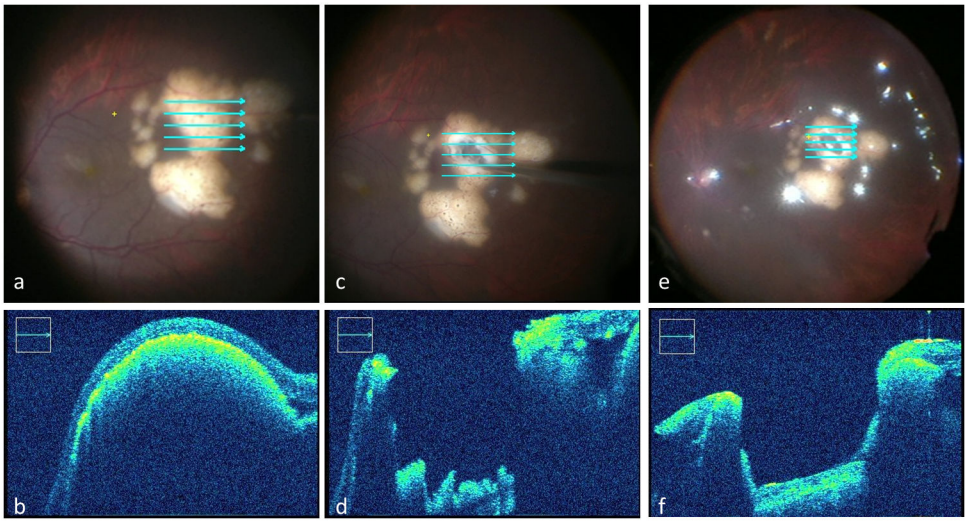

Figure 3.

Case B: iOCT demonstrates tissue microanatomy before biopsy (a,b) during biopsy (c,d) and after fluid-air exchange (e,f).

Table 1

Case summaries.

Case	Gender	Age	Laterality	Preoperative Diagnosis	Procedure	Location Biopsied	Diagnosis
A	Male	84	Right	Vitritis Subretinal lesion	Dx PPV CR Biopsy Endolaser SO I	Vitreous Choroid and Retina	Primary Intraocular diffuse large B-cell lymphoma
B	Female	52	Right	Vitritis Subretinal lesion	Dx PPV SR biopsy FAX SF6 Gas	Vitreous Retina Subretinal Space	Primary CNS arge B-cell lymphoma with choroidal infiltrates and vitritis
C	Female	64	Left	Vitritis Subretinal lesion	Dx PPV SR Biopsy AFX	Vitreous Retina Subretinal Space	Primary intraocular large cell lymphoma
D	Female	72	Right	Vitritis Subretinal lesion	Dx PPV SR Biopsy AFX	Vitreous Retina Subretinal Space	Intraocular large B-cell lymphoma in the setting of prior lymphoproliferative disorder
E	Male	71	Right	Vitritis Subretinal lesion Vitreous opacities	Dx PPV AFX	Vitreous	Primary intraocular B-cell lymphoma
F	Male	69	Right	Subretinal lesion of unknown etiology status post negative FNAB	Dx PPV SR biopsy FAx Endolaser SF6 Gas	Vitreous Retina Subretinal Space	Posterior scleritis