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The Value of Intraoperative OCT Imaging in Vitreoretinal Surgery

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Abstract

Purpose of review—To evaluate the role of intraoperative OCT (iOCT) in vitreoretinal surgery, assess the current state-of-the art and to examine possible future directions in the field.

Recent findings—Numerous vitreoretinal surgical conditions and procedures have been described utilizing iOCT. These conditions include macular holes, epiretinal membranes, retinal detachments, and retinopathy of prematurity. Significant alterations appear to occur during surgical manipulations in many of these conditions that can be identified with iOCT. The most common current systems used are portable OCT probes that are either mounted to a microscope or used in a handheld fashion. Prototypes are also being utilized that are integrated into the microscope to allow for true “real-time” imaging of instrument-tissue interactions. Current generation surgical instrument materials (e.g., metal) limit optimal visualization with integrated OCT systems due to shadowing and light scattering properties.

Summary—The role of iOCT in vitreoretinal surgery continues to be defined by active research and enhancements to integrative technologies. Further research is needed to better define the specific applications of iOCT that impact patient outcomes and surgical decision-making. Future advancements in integrative systems, OCT-friendly instrumentation, and software algorithms will further expand the horizon of iOCT in the vitreoretinal surgical theater. As OCT transformed the clinical management of the vitreoretinal conditions, iOCT has the potential to be a paradigm-shifting technology in the operating room.

Keywords

OCT; intraoperative OCT; iOCT; retina; surgery; vitreoretinal surgery

Introduction

Vitreoretinal surgery has undergone significant paradigm shifts over the last few decades that have advanced patient care and expanded our surgical tool kit. Improvements to surgical visualization have often resulted in incremental deviations from previous standards in order

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to create new expectations for surgical outcomes. Early examples of advances include the surgical microscope and the subsequent foot-pedal control of translational microscope motion to allow for improved surgeon-control during procedures.¹⁻⁴ More recently wide-angle viewing systems, enhanced illumination, and small gauge surgery have dramatically impacted the feasibility of various procedures and improved surgical approaches to complex vitreoretinal diseases.⁵

In the clinical management of our patients, few recent development can compare to the impact that optical coherence tomography (OCT) has played in diagnosis, management, and monitoring of vitreoretinal diseases. The advent of anti-vascular endothelial growth factor (VEGF) medications and the subsequent trials using OCT-based management schemes have resulted in a significant paradigm shift to OCT-assisted clinical care.^{6, 7} Not only has OCT been critical for the management of VEGF-driven diseases (e.g., diabetic retinopathy, age-related macular degeneration, retinal venous occlusive disease), but in addition, OCT has been instrumental in optimizing the diagnosis and visualization of vitreoretinal interface disorders [e.g., macular hole (MH), epiretinal membrane (ERM), vitreomacular traction (VMT)].⁸

In the same way that OCT has transformed the clinical management of vitreoretinal conditions, integration of OCT technology into the operating room theater may have significant impacts in the surgical management of vitreoretinal conditions. This review highlights the current state-of-the-art of intraoperative OCT (iOCT) including an examination of clinical applications, integrative OCT technology, surgical instrumentation, and software algorithms.

Clinical Applications

Numerous vitreoretinal surgical diseases have been described with iOCT. These include macular hole, epiretinal membrane, retinal detachment, vitreomacular traction, and others. In these conditions, iOCT has identified significant architectural alterations that occur following surgical manipulations.

Macular hole

Multiple studies have examined iOCT during macular hole (MH) surgery. Imaging has been able to be performed both prior to and following internal limiting membrane (ILM) peeling during surgical repair.⁹⁻¹⁵ Significant alterations in anatomy have been identified, including variable changes in MH geometry and outer retinal alterations.^{9, 10, 12, 14, 15} Visualization of ILM curling on iOCT following successful peeling and focal areas of retinal elevation at the initiation sites for instrument-tissue interaction has been described.^{9, 10, 12}

In the largest series to date, MH volume and base area increased following ILM Peeling; while MH apex area decreased following ILM peeling.⁹ Outer retinal changes have been described in multiple reports following surgical manipulation. In particular, following ILM peeling, expansion of the distance between the retinal pigment epithelium (RPE) and the ellipsoid zone [i.e., inner segment/outer segment (IS/OS) band] as well as increased lateral extension of this expansion have been documented with iOCT.^{9, 10} These architectural

alterations have been examined in association with both functional and anatomical outcomes.⁹ In addition to baseline MH geometry, alterations in the outer retina and MH configuration identified with *i*OCT were associated with final visual acuity. Anatomical surgical success (i.e., MH closure) was significantly associated with intraoperative MH geometry and alterations in MH geometry that were identified with *i*OCT.⁹

Epiretinal membrane

Similar to MH surgery, ERM surgery appears to be amenable to *i*OCT feedback.^{10–12, 14–16} Following membrane peeling, outer retinal changes have been described. These changes appear to occur in the area the ERM and/or ILM has been peeled. In particular, there appears to be a broad expansion of the distance between the RPE and the ellipsoid zone resulting in increased subretinal hyporeflectivity on *i*OCT (FIGURE 1).^{10, 16} Focal areas of retinal elevation at the peel initiation site have also been documented in these cases using *i*OCT.^{10, 16} The functional significance of these changes remains unclear. One critical role that *i*OCT may have is identification of subclinical residual membranes that require additional membrane peeling.^{3, 15, 17}

Retinal detachment

Prognostication in cases of macula-involving rhegmatogenous retinal detachments remains challenging for the clinician. Utilizing *i*OCT, multiple features have been identified during vitrectomy surgery with perfluorocarbon tamponade.^{18–20} In nearly all cases, a variable amount of subclinical persistent submacular fluid remains following application of perfluorocarbon. The amount of subretinal fluid varies significantly and may have prognostic significance for visual outcomes based on preliminary analyses.²⁰ Additionally, variable foveal configurations have been described, including occult full-thickness MH formation in select cases.¹⁸ Although documented on *i*OCT, these cases did not develop clinical MH in the early postoperative period. Interestingly, final visual acuity was reduced in these cases and in one eye a FTMH developed several months following retinal detachment repair.¹⁸ Other findings, such as the integrity of the ellipsoid zone under perfluorocarbon liquid, may also have prognostic significance.²⁰ The *i*OCT findings during retinal detachment highlight the potential for this technology beyond the more obvious role of feedback following membrane peeling. The potential prognostic utility of *i*OCT in RD repair is an area that is not initially intuitive and emphasizes the importance of continued exploration for clinical applications of *i*OCT.

Other vitreoretinal conditions

Multiple other conditions and procedures have been described using *i*OCT. The use of *i*OCT during surgical repair of VMT syndrome has been described and may have potentially multiple important feedback milestones during surgical intervention.^{12, 17, 21} Identification of subclinical full-thickness MH development, unroofed cysts, and residual membranes are all important alterations that may occur during surgical intervention that *i*OCT may identify that would otherwise go unnoticed.^{17, 21} In fact, one study suggested that *i*OCT may alter the surgical procedure (e.g., gas tamponade, additional membrane peeling) in more than

one-third of cases to address subclinical findings on *i*OCT (e.g., MH formation, residual membrane).²¹

Optic pit-associated maculopathy is a challenging surgical condition whose pathogenesis remains controversial. Using *i*OCT, the architectural alterations that occur during surgical repair for macular schisis have been documented.²² Following aspiration over the pit, a significant reduction in the area of schisis was noted suggesting a direct connection between the vitreous cavity and the macular schisis.²²

Our understanding of retinopathy of prematurity (ROP) has also been enhanced through the use of *i*OCT. Areas of retinoschisis and preretinal structures have been identified with intraoperative OCT that was not previously appreciated clinically.²³ The identification of these structures may impact surgical approach and clinical decision-making through the use of *i*OCT.

OCT Devices and Technology

Although early research has already enhanced our understanding of vitreoretinal surgical diseases and the impact of surgical maneuvers on the underlying tissues, significant hurdles exist for the widespread use of *i*OCT. Current tabletop systems lack portability and do not allow for practical use in the operating room. The current systems that are most commonly used are the Bioptigen SDOIS/Envisu portable system (Bioptigen, Research Triangle Park, NC) and the Optovue IVue (Optovue, Fremont, CA) system. Modified tabletop systems (e.g., Heidelberg) have also been described to optimize the potential for intraoperative use. All of these systems include probes or modified scan heads that have significant advantages over standard tabletop devices regarding their portability and maneuverability within the operating room.

These systems can typically be used in the operating room in a handheld fashion, on an external mounting system, or attached to the microscope (Figure 2). Handheld imaging provides significant degrees of freedom regarding scan angles and probe orientation, but may have a significant learning curve, suffers from motion artifacts, and may pose challenges for the user in a sterile field. Utilizing a mount system, the probe has increased stability for the user and may enhance scan efficiency and reproducibility. Utilizing a microscope-mounted portable system, the microscope foot-pedal controls provide the surgeon with precision movements of the probe while maintaining stability. The joystick provides X-Y translational control of the probe and the focus pedal provides Z-axis control of the probe.^{9, 10, 17, 18}

All of these systems allow for the surgeon to obtain immediate feedback during surgical procedures. However, all of these devices require the surgeon to halt surgery prior to performing the scan. Using this type of system design, the surgeon can identify changes to tissue configurations immediately following an intervention but it does not allow for real-time imaging of those manipulations. Additionally, halting surgery for image acquisition results in increased surgical time and also requires the additional OCT system footprint to be in the operating room.¹⁷

In order to truly seamlessly integrate OCT into the operating room, the real-time feedback to the surgeon will likely come through a microscope integrated OCT system. With a combined optical pathway, the microscope and OCT system could be parfocal with the potential of increasing scan efficiency and image quality. Additionally, real-time visualization of surgical maneuvers and tissue-instrument interactions would be possible. Multiple prototypes have been developed and described.^{11, 14, 17, 24, 25} Cynthia Toth, MD and Joseph Izatt, PhD were lead developers on one of the first microscope integrated OCT systems which was designed for a Leica (Leica, Wetzlar, Germany) surgical microscope.^{14, 24, 25} Suzanne Binder, MD has reported on a modified Cirrus (Carl Zeiss Meditec, Oberkochen, Germany) microscope integrated system.¹¹ Haag-Streit Surgical (Haag-Streit, Koeniz, Switzerland) in collaboration with OPMedT (OPMedT, Lubeck Germany) has also developed a microscope integrated OCT system.²⁶ Subsequently, second-generation integrated OCT prototypes have been developed including a system at the Cleveland Clinic (Figure 2) and a second-generation Carl Zeiss Meditec system, the Rescan 700.¹⁷ Both systems utilize heads-up display capabilities, a key component for surgeon feedback. The Rescan 700 utilizes an OCT system built into the Lumera 700 microscope eliminating the additional footprint of the OCT system from around the head of the microscope.

Microscope integrated systems allow for the surgeon to directly visualize “real-time” tissue-instrument interactions.^{24, 27} Customized scan patterns and imaging protocols will be necessary to optimally visualize and capture these interactions in a pseudo-video fashion. In fact, using various approaches, video-like OCT imaging of membrane peeling and tissue/instrument interactions have been able to be captured using these integrated systems.²⁷

Although microscope integrated systems have been a landmark development in the translation to seamless intraoperative imaging. One major hurdle that remains is targeting the OCT field-of-view to the area of interest. The ability to perform active tracking will improve imaging efficiency and enhance visualization of real-time maneuvers. Currently, manual movement of the OCT field through a user-input control is the easiest solution. However, automated aiming will ultimately be critical for rapid surgeon feedback and advancement of other integrative features. Various possibilities exist that could result in automated OCT localization. One possibility is to specifically label surgical instrumentation for OCT tracking that could act as a tracer to guide the OCT field to the area of interest. A second alternative is through software or hardware algorithms that rapidly track positional changes (e.g., instrument movement) noted in a relatively static field (e.g., the retinal surface). This information could be used to guide the scanning beam to the instrument tip. A third alternative is direct integration of the OCT scanner into the tip of the surgical instrument.²⁸ However, this dramatically impacts the overall integration of OCT into the surgical procedure due to it being limited to only those instruments equipped with the fiber and is fundamentally limited in resolution and field-of-view.

Ultimately, the viewing interface for the OCT data will need to be optimized for surgical integration. In most current systems, the OCT scan is displayed on an external monitor requiring that the surgeon look away from the surgical field. In order to visualize OCT-based surgical maneuvers while operating, the display will need to be simultaneously

provided within the view of the surgical field. Head-up displays are in widespread use in other industries and have been adapted for use in neurosurgical scopes to integrate MRI or CT-scan data. In ophthalmology, heads-up displays have now become a common feature of many newer surgical microscopes with integration of various clinical data points (e.g., corneal landmarks). Two current integrated prototypes, the Cleveland Clinic prototype system and the Carl Zeiss Meditec Rescan 700, have utilized heads-up display systems.²⁹ An important component of the surgeon feedback system will be to provide a filter for surgery-critical data to minimize surgeon distraction and information overload.

Surgical Instrumentation

Prior to microscope integrated OCT systems, the OCT properties of current surgical instrumentation were unknown. The shadowing properties of a particular instrument or material are critical to visualizing underlying tissues. Additionally, the light scattering nature of the instrument/material is a key property in instrument visualization on OCT imaging. Utilizing a microscope integrated OCT system, the OCT properties of standard surgical instruments have been characterized.²⁴ Metallic instruments resulted in total shadowing of the underlying tissue with very high reflectivity, whereas silicone instruments resulted in less shadowing and moderate reflectivity. Changing from metallic to silicone improved visualization of the underlying tissue and the instrument on OCT.²⁴ Research is underway evaluating novel materials to optimize the optical and material properties for potential OCT-friendly surgical instruments. Prototypes have been developed which appear to have excellent OCT-based visualization of both underlying tissues and the actual instrument tip (Figure 3).³⁰

Software Algorithms

Current software analysis packages in tabletop clinical systems are designed for changes that typically occur over long periods of time. Major progress in OCT software packages is needed for real-time analysis capabilities for intraoperative applications. Recently, analysis algorithms for pathology specific segmentation (e.g., volumetric MH analysis) have been described and utilized to analyze subtle changes in MH architecture following ILM peeling (Figure 4).^{9, 31} Further enhancements to facilitate analysis of outer retinal alterations identified following surgical maneuvers are needed to better delineate these changes and their associations with functional variables. Software packages to assist in localization of the scanning beam to the area of surgical manipulation may also have significant utility. In addition to localization, software-based image processing could be used to minimize shadowing from instrumentation through real-time averaging of adjacent scans through spatial compounding.²⁷

Conclusion

*i*OCT provides the opportunity to achieve a greater understanding of the pathophysiology of vitreoretinal surgical diseases in ways that are not possible in the clinic setting. The widespread clinical impact of *i*OCT has yet to be determined. Current research suggests that *i*OCT will reveal new information regarding the impacts of surgical maneuvers on the

tissues. Studying these ultrastructural changes may help us to better understand the variations in visual recovery following surgery for a multitude of conditions, such as retinal detachment and vitreomacular interface disorders. Additional research is needed to determine whether this will ultimately alter surgical decision-making and improve clinical outcomes for our patients, but *i*OCT continues to be an exciting new area of investigation.

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Abbreviations

OCT	optical coherence tomography
<i>i</i>OCT	intraoperative optical coherence tomography
MH	macular hole
ILM	internal limiting membrane
VEGF	vascular endothelial growth factor
ERM	epiretinal membrane
VMT	vitreomacular traction

References

1. Machemer R, Buettner H, Parel JM. Vitrectomy, a pars plana approach. Instrumentation. *Mod Probl Ophthalmol.* 1972; 10:172–177. [PubMed: 5056323]
2. Machemer R, Parel JM. An improved microsurgical ceiling-mounted unit and automated television. *Am J Ophthalmol.* 1978; 85(2):205–209. [PubMed: 623191]
3. Parel JM, Machemer R, Aumayr W. A new concept for vitreous surgery. 5. An automated operating microscope. *Am J Ophthalmol.* 1974; 77(2):161–168. [PubMed: 4812085]
4. Parel JM, Machemer R, Aumayr W. A new concept for vitreous surgery. 4. Improvements in instrumentation and illumination. *Am J Ophthalmol.* 1974; 77(1):6–12. [PubMed: 4824177]
5. Spitznas M. A binocular indirect ophthalmomicroscope (BIOM) for non-contact wide-angle vitreous surgery. *Graefes Arch Clin Exp Ophthalmol.* 1987; 225(1):13–15. [PubMed: 3569944]
6. Martin DF, Maguire MG, Ying GS, et al. Ranibizumab and bevacizumab for neovascular age-related macular degeneration. *N Engl J Med.* 2011; 364(20):1897–1908. [PubMed: 21526923]
7. Fung AE, Lalwani GA, Rosenfeld PJ, et al. An optical coherence tomography-guided, variable dosing regimen with intravitreal ranibizumab (Lucentis) for neovascular age-related macular degeneration. *Am J Ophthalmol.* 2007; 143(4):566–583. [PubMed: 17386270]
8. Puliafito CA, Hee MR, Lin CP, et al. Imaging of macular diseases with optical coherence tomography. *Ophthalmology.* 1995; 102(2):217–229. [PubMed: 7862410]
9. Ehlers JP, Xu D, Kaiser PK, et al. INTRASURGICAL DYNAMICS OF MACULAR HOLE SURGERY: An Assessment of Surgery-Induced Ultrastructural Alterations with Intraoperative Optical Coherence Tomography. *Retina.* 2013 This report quantitatively and qualitatively assesses the alterations that occur during macular hole surgery. Preliminary analysis suggests these alterations may be associated functional and anatomic outcomes.
10. Ray R, Baranano DE, Fortun JA, et al. Intraoperative Microscope-Mounted Spectral Domain Optical Coherence Tomography for Evaluation of Retinal Anatomy during Macular Surgery. *Ophthalmology.* 2011; 118(11):2212–2217. [PubMed: 21906815]

11. Binder S, Falkner-Radler CI, Hauger C, et al. Feasibility of intrasurgical spectral-domain optical coherence tomography. *Retina*. 2011; 31(7):1332–1336. [PubMed: 21273942] This report describes the use Zeiss microscope intraoperative prototype system for imaging during vitreoretinal surgery.
12. Dayani PN, Maldonado R, Farsiu S, Toth CA. Intraoperative use of handheld spectral domain optical coherence tomography imaging in macular surgery. *Retina*. 2009; 29(10):1457–1468. [PubMed: 19823107]
13. Hayashi A, Yagou T, Nakamura T, et al. Intraoperative changes in idiopathic macular holes by spectral-domain optical coherence tomography. *Case Report Ophthalmol*. 2011; 2(2):149–154.
14. Hahn P, Migacz J, O'Donnell R, et al. Preclinical evaluation and intraoperative human retinal imaging with a high-resolution microscope-integrated spectral domain optical coherence tomography device. *Retina*. 2013; 33(7):1328–1337. [PubMed: 23538579] This report describes the translation of a microscope integrated system from the laboratory environment to the vitreoretinal operating room.
15. Pichi F, Alkabes M, Nucci P, Ciardella AP. Intraoperative SD-OCT in macular surgery. *Ophthalmic Surg Lasers Imaging*. 2012; 43(6 Suppl):S54–S60. [PubMed: 23357325]
16. Ehlers, JP.; Roth, B.; Kaiser, PK., et al. Assessment of microarchitectural retinal dynamics of epiretinal membrane surgery utilizing intraoperative optical coherence tomography. *Macula Society Annual Meeting*; Dana Point, CA. 2013.
17. Ehlers, JP.; Kaiser, PK.; Singh, RP., et al. Application of intraoperative OCT to ophthalmic surgery: PIONEER 18-month iOCT vitreoretinal results. *American Society of Retina Specialists Annual Meeting*; Toronto, Canada. 2013.
18. Ehlers JP, Ohr MP, Kaiser PK, Srivastava SK. Novel microarchitectural dynamics in rhegmatogenous retinal detachments identified with intraoperative optical coherence tomography. *Retina*. 2013; 33(7):1428–1434. [PubMed: 23609120] This report describes the findings in macula-involving retinal detachments as visualized with iOCT, including persistent subretinal fluid and foveal alterations.
19. Lee LB, Srivastava SK. Intraoperative spectral-domain optical coherence tomography during complex retinal detachment repair. *Ophthalmic Surg Lasers Imaging*. 2011; 42:e71–e74. Online. [PubMed: 21830748]
20. Srivastava, SK.; Kaiser, PK.; Singh, RP., et al. Intraoperative spectral domain OCT during pars plana vitrectomy for macula involving retinal detachments. *American Society of Retina Specialists Annual Meeting*; Toronto, Canada. 2013.
21. Ehlers JP, Tam T, Kaiser PK, et al. Utility of intraoperative optical coherence tomography during vitrectomy surgery for vitreomacular traction syndrome. *Retina*. 2014 *In press*.
22. Ehlers JP, Kernstine K, Farsiu S, et al. Analysis of pars plana vitrectomy for optic pit-related maculopathy with intraoperative optical coherence tomography: a possible connection with the vitreous cavity. *Arch Ophthalmol*. 2011; 129(11):1483–1486. [PubMed: 22084218]
23. Chavala SH, Farsiu S, Maldonado R, et al. Insights into advanced retinopathy of prematurity using handheld spectral domain optical coherence tomography imaging. *Ophthalmology*. 2009; 116(12):2448–2456. [PubMed: 19766317]
24. Ehlers JP, Tao YK, Farsiu S, et al. Integration of a spectral domain optical coherence tomography system into a surgical microscope for intraoperative imaging. *Invest Ophthalmol Vis Sci*. 2011; 52(6):3153–3159. [PubMed: 21282565] This report describes one of the first microscope integrated systems and also provides an analysis of the OCT characteristics of current surgical instrumentation.
25. Tao YK, Ehlers JP, Toth CA, Izatt JA. Intraoperative spectral domain optical coherence tomography for vitreoretinal surgery. *Opt Lett*. 2010; 35(20):3315–3317. [PubMed: 20967051]
26. Steven P, Le Blanc C, Velten K, et al. Optimizing descemet membrane endothelial keratoplasty using intraoperative optical coherence tomography. *JAMA Ophthalmol*. 2013; 131(9):1135–1142. [PubMed: 23827946]
27. Ehlers JP, Tao YK, Farsiu S, et al. Visualization of real-time intraoperative maneuvers with a microscope-mounted spectral domain optical coherence tomography system. *Retina*. 2013; 33(1):232–236. [PubMed: 23190928] This report describes a novel scan protocol with associated image

processing to allow for visualization of near-video level OCT imaging of intraoperative maneuvers.

28. Balicki M, Han JH, Iordachita I, et al. Single fiber optical coherence tomography microsurgical instruments for computer and robot-assisted retinal surgery. *Med Image Comput Comput Assist Interv.* 2009; 12(Pt 1):108–115. [PubMed: 20425977]
29. Ehlers, JP.; Kaiser, PK.; Yuan, A., et al. PIONEER: A prospective intraoperative and perioperative OCT study-6-month vitreoretinal results. American Society of Retina Specialists Annual Meeting; Las Vegas, NV. 2012.
30. Ehlers, JP.; Srivastava, SK.; Tao, YK., et al. Integrative Advancements for Intraoperative Optical Coherence Tomography. American Society of Retina Specialists Annual Meeting; Boston, MA. 2011.
31. Xu D, Yuan A, Kaiser PK, et al. A novel segmentation algorithm for volumetric analysis of macular hole boundaries identified with optical coherence tomography. *Invest Ophthalmol Vis Sci.* 2013; 54(1):163–169. [PubMed: 23221077] This report describes a novel analysis algorithm that segments the boundaries of a macular hole, allowing for volumetric analysis and three dimensional reconstruction.

Key Points

- A. Numerous vitreoretinal surgical diseases have been described with intraoperative OCT (*i*OCT) and subclinical architectural alterations following surgical maneuvers are often seen.
- B. Significant recent advances have been described in *i*OCT including microscope integrated OCT systems, software algorithms, and OCT-compatible surgical instruments.
- C. Intraoperative OCT (*i*OCT) has the potential to be a disruptive technology and transformative tool in the surgical management of vitreoretinal diseases.

Figure 1.

Epiretinal membrane and *i*OCT. (A) Pre-peel *i*OCT scan showing prominent epiretinal membrane (red arrow). (B) Post-peel scan confirms removal of the epiretinal membrane (yellow arrow) and reveals areas of increased subretinal hyporeflectivity in the areas of peeling (orange arrows). *i*OCT: intraoperative optical coherence tomography.

Figure 2. Systems utilized for intraoperative scanning. (A) Microscope-mounted portable OCT probe (red circle). (B) Second-generation microscope integrated OCT prototype (yellow area) allowing for simultaneous surgeon viewing and OCT scanning.

Figure 3. Macular hole segmentation algorithm showing three dimensional reconstruction of the hole configuration.

Figure 4. OCT-friendly instrumentation. (A) Color photograph of a prototype surgical pick tip composed of novel material for OCT-scanning. (B) OCT B-scan of prototype surgical pick with minimal shadowing of underlying material and excellent visualization of the instrument tip.