Editorial

Intraoperative Spectral Domain Optical Coherence Tomography; Its Time has Come

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Vitreoretinal surgery has experienced an explosion of advances in the last decade and a half. New advances in pars plana vitrectomy systems including small-gauge instrumentation have provided many potential benefits to patients and surgeons. These include more efficient surgery; decreased postoperative inflammation leading to less pain and more patient comfort; improved cosmetic appearance following surgery; decreased astigmatic changes; and more rapid visual recovery. Pharmacotherapy and chromovitrectomy have facilitated pars plana vitrectomy and peeling of membranes. Better visualization with better microscopes and optics is also available. Advances and technology continue to add to the explosion of possibilities available in our armamentarium.

Spectral-domain optical coherence tomography (SD-OCT) is a rapid, noncontact and noninvasive method of imaging intraocular tissues that has significantly contributed to the understanding, diagnosis, preoperative evaluation, and follow-up of macular diseases. SD-OCT has become the gold standard to evaluate these patients before and after surgery.

In this issue of JOVR, Riazi-Esfahani et al[1] report a very timely and well written study titled "Macular Surgery Using Intraoperative Spectral Domain Optical Coherence Tomography". In this retrospective case series on patients who underwent macular surgery with concurrent intraoperative SD-OCT for full thickness macular hole (MH), vitreomacular traction (VMT) or epiretinal membrane (ERM), the authors wished to evaluate intraoperative SD-OCT for detecting anatomical changes during macular surgery.

Intraoperative use of SD-OCT for macular surgery may provide the surgeon with immediate information about anatomical changes during surgery, such as the presence of subretinal fluid, fluid dynamics, traction and amount of surgical trauma.[2] The literature on the intraoperative use of SD-OCT in retinal surgeries is quite scarce with very few cases reported.[3,4] To the best of my knowledge, Riazi-Esfahani et al[1] report the largest series to date of patients undergoing concurrent pars plana vitrectomy and intra-operative SD-OCT.

In their consecutive case series, 32 eyes of 32 patients underwent concurrent pars plana vitrectomy and intraoperative SD-OCT for vitreoretinal interface disorders. The authors assessed intraoperative changes in macular hole dimensions and retinal thickness in patients with ERM and VMT owing to surgical manipulation using a hand-held SD-OCT system. SD-OCT images of 16 eyes with macular hole were subjected to quantitative and qualitative analysis. All MH dimensions remained stable during consecutive stages of surgery except MH apex diameter, which showed a significant decrease after ILM peeling ($P = 0.025$). Quantitative analysis of ten patients with ERM showed a significant decrease in retinal thickness after membrane removal ($P = 0.018$), which did not remain significant until the end of the procedure ($P = 0.8$). In 3 cases, subretinal fluid was formed after ILM-peeling. Quantitative analysis of 5 patients with VMT showed a decrease in retinal thickness during consecutive steps of surgery, although these changes were not significant. In two cases subretinal fluid was formed after ILM-peeling.[1] The authors conclude that intraoperative SD-OCT is a useful imaging technique which provides vitreoretinal surgeons with rapid awareness of intraoperative changes in macular anatomy and therefore may result in better anatomical and visual outcomes.[1]

Limitations of the study include small sample size, retrospective nature, short follow-up period, and the fact that the use of a hand-held device is cumbersome. The hand-held unit must be properly stabilized to obtain good images, and potential complications may occur if the instrument breaches operative field sterility. This hand-held OCT system also lacks a normative database. In addition, there is a lack of control group in the current study to determine if intraoperative SD-OCT does in fact improve anatomical and functional outcomes of surgery. Nevertheless, in 8 (25%) cases, the surgical technique was changed due to intraoperative SD-OCT's qualitative findings including cases where residual ERM or ILM were obvious by OCT without need for staining.

The use of intraoperative SD-OCT with a hand-held device must be differentiated from the use of real-time intraoperative SD-OCT evaluation[4,5] performed by combining it with the surgical microscope. Real-time intraoperative SD-OCT might improve the judgment of vitreoretinal structures even more, facilitate surgery, support intraoperative decisions, and finally potentially improve anatomical and functional outcomes. It may provide us with immediate information about anatomical changes during surgery with greater ease than the hand-held OCT. In addition, it may allow examination of patients who are unable to sit upright (for example, preoperative retinal scans for pediatric retinal surgery). Hand-held SD-OCT units can continue to achieve this for cases in which surgery is not planned. Real-time intraoperative SD-OCT is already commercially available (Rescan 700 OCT, Carl Zeiss Meditec, Jena, Germany).

The best intraoperative SD-OCT images are obtained in patients who are pseudophakic and have clear cornea and vitreous. If a cataract progresses during surgery, or if the cornea becomes edematous, it is more difficult to get an image. It is important to keep the cornea hydrated and keep operative time short. In the series by Riazi-Esfahani et al,[1] 4 cases (12.5%) had low quality images (due to old corneal opacity, stromal corneal edema after phacoemulsification, posterior capsule opacity and a silicone filled eye) and were not included in the final analysis. However, this study is important because it demonstrates that hand-held SD-OCT provides an efficient, practical method for intraoperative retinal imaging that can easily be incorporated into retinal surgical practice, adding a novel perspective of the retina and excellent results in the largest series to date. With current technology, this allows the surgeon real-time assessment of surgical results, potentially enhancing surgical outcomes and reducing the need for reoperations, thereby avoiding additional costs and morbidity for the patient.

In the future, technology will allow higher resolution and precision through a tracking device, and new devices will be available which may not require halting of surgical manipulations to acquire images using a shared optical path between the SD-OCT device and the surgical microscope. This will enable simultaneous OCT imaging and surgical manipulations.[5] In addition, a surgical OCT probe may be possible (Mura M. Riyadh, Saudi Arabia. Unpublished Data). Some groups have reported integration of an OCT scanner into an intraocular probe with successful imaging of intraocular structures in model eyes.[6,7]

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