Low Illumination 3-D Heads-Up Vitrectomy for Diabetic Macular Edema

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Abstract

Vitrectomy with membrane peeling remains an important option for diabetic macular edema (DME) that is refractory to pharmacologic therapy, and for DME with significant tractional components. In this case, we demonstrate how we use the 3-dimensional heads-up surgical platform (Ngenuity®; Alcon, Fort Worth) to perform low-illumination vitrectomy with membrane peeling for a patient with DME with an overlying epiretinal membrane.

Article

We have made tremendous strides in the past decade in caring for patients with diabetic macular edema (DME). Physicians and patients now have multiple pharmacologic options to optimally individualize care for DME, including bevacizumab (Avastin®, Genentech, South San Francisco, CA), ranibizumab (Lucentis®, Genentech), aflibercept (Eylea®, Regeneron, Tarrytown, NY), triamcinolone (Triesence®, Alcon, Fort Worth, TX), dexamethasone (Ozurdex®, Allergan, Irvine, CA), and fluocinolone (Iluvien®, Alimera, Alpharetta, GA), and many more on the horizon. But before any of these great options were available, we had focal macular laser photocoagulation (which is still beneficial for extrafoveal edema), and if laser did not work, it was vitrectomy.2-4

A taut posterior hyaloid and vitreomacular traction can exacerbate the retinal vascular incompetence that is the hallmark of diabetic retinopathy pathogenesis. Vitrectomy for DME is therefore still an important component of the retina surgeon’s armamentarium for patients with edema refractory to pharmacologic treatment, or for DME with a significant tractional component. Vitrectomy has also made many advances in the past decade. Some important milestones include wide-angle viewing, smaller gauge instrumentation, and higher cut speeds that have made surgery safer, more efficient, and less traumatic.5 The next big wave in vitrectomy is likely to be 3-D heads-up surgery.6 In 3-D surgery, the surgeon sits back in their chair (literally) and views a large 3-D monitor instead of a microscope. There are many advantages to heads-up surgery that are discussed below. Herein, we describe a patient who underwent 3-D heads-up vitrectomy with membrane peeling for DME with a tractional component.

The Patient

A 60-year-old pseudophakic woman with long-standing insulin-independent diabetes mellitus presented with worsening vision in both eyes for many years. Her visual acuity was hand motions in the right eye and 20/200 in the left eye. Intraocular pressures were 13 and 11 mm Hg, respectively. Iris and angle neovascularization were not noted. Fundus examination revealed bilateral macula-involving tractional retinal detachment with stretch breaks and subretinal fluid. The left eye first underwent 25-gauge (G) pars plana vitrectomy with segmentation and delamination of the proliferative membranes, endolaser, and SF₆ tamponade.
Several weeks later, the right eye underwent vitrecomy with membrane peeling and silicone oil tamponade. Due to the densely adherent membranes with tight surgical spaces, the “hybrid” 25G/27G vitrectomy technique was used as we have previously described, whereby we start the case with 25G instrumentation, and then use a 27G vitreous cutter through the 25G cannulas. This technique allows us to make use of harder 25G (or 23G) instrumentation that is not available in 27G, such as lighted pics and forceps with larger platforms, combined with the benefit of the 27G vitreous cutter that can dissect into the smallest surgical planes.

Causes of Edema

The retina in both eyes settled nicely, but spectral domain optical coherence tomography (SD-OCT) several months later showed macular edema in the left eye. The contralateral eye remained flat under oil. The edema in this case can be attributed to three causes: diabetic macular edema, post-surgical cystoid macular edema, and tractional retinal thickening from an epiretinal membrane. Fluorescein leakage of the disc is commonly seen in post-surgical macular edema, which is not the case in our patient. The leakage is most notable in the superior macula, where the epiretinal membrane is most prominent - but the leakage appears to be too substantial for that seen in isolated epiretinal membranes (Figure 1A-B). In our patient, the edema is likely due to a combination of DME and retinal thickening from the membrane. The decision was made to undergo vitrectomy with membrane peeling.

3-D Heads-Up Membrane Peeling

The surgery was performed using a 3-dimensional heads-up display system (Ngenuity®, Alcon, Fort Worth, TX) (Figure 2A-D). A large 3-D high-definition (HD) 8-million pixel monitor is placed at the foot of the patient’s bed, and the surgeon (as well as everyone else in the room) wears polarized glasses to operate without looking into a microscope. The benefits are numerous: (1) Ergonomically it is the best option - you are literally sitting back in your chair. It may add years to your operating career. (2) For the first time, everyone in the room can see exactly what you are seeing. This is invaluable for teaching programs, and for the entire OR to be more involved in the surgery. (3) The optics allow for a fantastic view. Similar to new-generation smart phone cameras, Ngenuity® utilizes high dynamic range technology to optimize image quality by averaging multiple images with different exposures. (4) The iris aperture of the camera can be adjusted to allow low-illumination surgery. When working on the macula with a macular lens, we can reduce the endoillumination to < 10%, and open the aperture of the camera wider to allow light entry into the camera system. This substantially reduces the risk of phototoxicity. In the present case, we performed membrane peeling under the BIOM® (Oculus Surgical, Port St. Lucie, FL) without a macula lens, so the endoillumination was set at 20% (Figure 2A-C). (5) The gain and other parameters can be adjusted to optimize your view under difficult visualization situations. Decreasing glare when working under air is one popular feature (Figure 2D). (6) It greatly enhances the quality of your surgical videos - you can create either 2D or 3D videos.
Our patient underwent successful peeling of the epiretinal membrane and internal limiting membrane. The edema improved, and vision improved to 20/80 (Figure 1C). Figure 2 shows the intraoperative side-by-side views of the left and right eye cameras. During surgery, the images are fused for the 3-dimensional view. Alcon and TrueVision have many developments in the pipeline for this unique surgical platform, including incorporation of intraoperative OCT, endoscopic assisted vitrectomy, electronic health record integration, diagnostic overlays, and a system that will be completely independent of the microscope. Large paradigm shifts do not happen very often, but 3-D heads-up surgery may be the future of vitreoretinal surgery.

References


6. Yonekawa Y. 3-D heads-up vitreoretinal surgery: techniques and pearls for a new paradigm. Retina Today [In Press]


Figure Legends
Figure 1: Diabetic macular edema (DME) with tractional component. (A) Wide-field fluorescein angiography demonstrates leakage in the superior macula (arrow). (B) Optical coherence tomography shows macular edema with an epiretinal membrane (ERM) (arrow). (C) The retinal thickening has improved after vitrectomy and peeling of the ERM and internal limiting membrane.

Figure 2: 3-D heads-up vitrectomy with Ngenuity®. Peeling of the epiretinal membrane (ERM) and internal limiting membrane (ILM) were performed under the BIOM, with indocyanine green staining. (A) The ERM was first peeled, and (B) residual ILM was subsequently removed. (C) Air fluid exchange was performed (for a lamellar macular hole) with very good visualization.
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60-year-old woman with long-standing diabetes with macular edema
Tractional component from overlying epiretinal membrane
Left and right eye displays using 3D heads-up platform (Images are fused during surgery)
Membrane peeling under the BIOM Endoillumination at 20%
ILM peeled also
Great optics during air fluid exchange
Edema and vision improved postoperatively