The incidence of diabetes is increasing worldwide. From 171 million people with diabetes in 2000, it is predicted that the total number of people with this disease will rise to over 366 million by 2030. Among these individuals, many will have vision loss secondary to diabetic macular edema (DME). Currently, focal/grid laser remains the primary treatment option for clinically significant macular edema (CSME). We now, however, have the option of treating DME with pharmacologic agents such as intravitreal steroids and anti-vascular endothelial growth factor (anti-VEGF) agents. Pharmacotherapy may indeed be the future for the treatment of DME, whether on its own or in combination with laser, and numerous clinical trials are under way to elucidate the role of these agents for DME. But what is the role of pars plana vitrectomy (PPV) in the management of DME?

This article reviews the role of PPV for the management of DME and proliferative diabetic retinopathy (PDR).

VITRECTOMY FOR DME

We first must ask whether surgery for DME makes sense. Does removal of the normal vitreous, removal of a taut posterior hyaloid, and further, peeling the internal limiting membrane (ILM), have utility in treating DME? Why would these surgical maneuvers help resolve DME and improve both vision and anatomic outcomes in patients who have previously failed to respond to conventional laser treatment or pharmacotherapy? In certain cases, the posterior hyaloid is thought to contribute to the development of DME. By exerting tangential forces on the retina, vitreomacular traction (VMT) can induce or exacerbate DME. Therefore, one possibility for why PPV may be effective in the management of DME is that by removing the posterior hyaloid, the VMT is relieved, therefore releasing the forces causing macular edema. Relief of VMT, however, is not the only mechanism by which PPV may be effective for DME. It is also possible that with a vitrectomy, vitreal oxygenation increases and removal of the posterior hyaloid spurs the release of growth factors, such as VEGF and insulin-like growth factor 1, from the retina, and these factors subsequently wash out into the vitreous cavity.

In 1992 Lewis et al. were the first to describe a positive effect of vitrectomy on DME in patients with a taut posterior hyaloid. In 10 patients with DME who under-
Figure 1. Color fundus photograph of an eye with proliferative diabetic retinopathy, diabetic macular edema, and vitreomacular traction (VMT). Visual acuity (VA) is 20/100 (A). Color fundus photograph of the same eye with line indicating location of optical coherence tomography (OCT) scan of the fovea (B). OCT scan of the same eye through the fovea. VMT is present with resultant macular thickening and a small amount of subretinal fluid (C). Macular thickness map created using volumetric OCT scan of the macula. Centrally, there is significant thickening, and the shape is pointed because of VMT (D). Color fundus photograph of the same eye following vitrectomy and removal of the posterior hyaloid with line indicating location of OCT scan of the fovea. VA is 20/40 (E). OCT scan of the same eye through the fovea following vitrectomy. The VMT has been relieved, there is significantly less thickening, and the subretinal fluid has resolved (F). Macular thickness map created using volumetric OCT scan of the macula following vitrectomy. There is significantly less macular thickening (G).
went PPV with separation of the posterior hyaloid, nine had improved vision and eight had resolution of macular edema. Since then, numerous studies have investigated the use of surgery for the management of DME. Many of these studies, however, are retrospective and include a relatively small sample size. Therefore, it is difficult to draw definitive conclusions from this body of literature. There are also a handful of prospective trials evaluating
Vitrectomy for diabetic macular edema, of which the overall findings are inconclusive.

Regardless of the lack of agreement on whether there is a definitive benefit in performing PPV for DME, it is our opinion that most retina physicians would agree that, for those patients with DME associated with VMT, the results are more promising. And with optical coherence tomography (OCT) we are able to better identify this subset of patients with DME. With OCT we have gained better insight into our understanding of the vitreomacular interface, and this imaging technology has now become an integral part in our evaluation of DME and its etiology.

Figure 1 shows the OCT of the left eye of a patient with PDR and macular edema with VMT. After 23-gauge PPV and removal of the posterior hyaloid, the macular edema resolved and visual acuity improved from 20/100 to 20/40.

Should the posterior hyaloid be removed in all cases of vitrectomy for DME? Do we need to be aggressive in doing so even if significant VMT is not apparent on OCT?

Figure 2 is an example of a patient who underwent vitrectomy for persistent macular edema after multiple focal laser treatments. After vitrectomy and removal of the posterior hyaloid, significant improvement of the macular edema occurred and the central retinal thickness improved from 456 um preoperatively to about 300 um postoperatively. There was also significant improvement in the visual acuity from 20/200 to 20/60.

Thus, there appears to be a role in removing the posterior hyaloid during vitrectomy for DME. Should we go even further: Does ILM removal improve results? Similar to the results for removal of the posterior hyaloid, there have been no definitive results as to the role that peeling the ILM has in the management of DME. In 2000, Gandorfer et al reported a near perfect success rate on the resolution of DME after removal of the posterior hyaloid and ILM. But was this directly a result of peeling the ILM? Some speculate that this is not the case and believe one possible explanation is that success may not necessarily come from removal of the ILM, but that it may in fact be attributed to the additional removal of residual vitreous cortex, therefore relieving the tractional forces on the macula. Although some groups have shown good results with ILM peeling, a fair number of studies have shown no advantage with respect to visual acuity improvement after PPV and ILM peeling.

VITRECTOMY FOR PDR

Advances in retina surgical instrumentation (eg, for 25-gauge, 25+, and 23-gauge surgery), improved lighting, and more sophisticated vitrectomy systems have enhanced our ability to handle complicated cases of diabetic retinopathy. The use of pharmaceutical adjuncts, such as intravitreal triamcinolone and anti-VEGF agents, have also improved the visualization of the vitreous and decreased neovascular proliferation, respectively.

With these advancements, surgery for PDR has become even safer with fewer complications. Therefore, earlier surgical intervention with PPV is now possible in some cases. Surgery continues to be recommended for foveal detachments, combined tractional/rhegmatogenous detachments, and patients with progressive overgrowth of the macula by fibrovascular tissue unresponsive to laser. Surgery is also indicated for dense premacular hemorrhage and epiretinal membranes with macular distortion.

Overall, surgical results for these conditions are variable. In a patient with fibrovascular overgrowth, despite good panretinal photocoagulation, continued progression can result in significant hemorrhage and ischemia. Surgery may be indicated in such cases, but postoperatively the outcomes are frequently poor. Similarly, dense premacular hemorrhage may also prove to be surgically challenging, as hemorrhage tends to become trapped in a pocket underneath the hyaloid, making visualization of underlying pathology difficult (Figure 3). Because of the potential for the hemorrhage to cause retinal toxicity, early intervention is often indicated. However, removal of the hemorrhage may reveal underlying traction, and the overall prognosis is guarded.

CONCLUSIONS

The question remains: Is surgery warranted for DME that is not associated with VMT? The posterior hyaloid and the ILM can be removed, but it is still unclear whether these surgical maneuvers will improve a patient’s condition. Theories exist as to why these surgical approaches may be effective; theories posit that posterior hyaloid and ILM removal result in a release of mechanical traction, improved oxygenation, and possibly release of growth factors from the retina into the vitreous. Better prospective studies are required, however, to shed light on this issue.

The Diabetic Retinopathy Clinical Research Network (DRCR.net) has investigated the question of whether or not PPV for DME is effective. This is a nonrandomized prospective study with the goal of providing information regarding the outcomes in eyes with DME that have had PPV. The study also hopes to identify which patients are the best candidates for PPV.

PPV and removal of the posterior hyaloid may be promising for select cases of DME, and advances in surgical instrumentation and surgical adjuncts will help
improve our ability to manage complications of proliferative diabetic retinopathy.

R. V. Paul Chan, MD, is an Assistant Professor of Ophthalmology at Weill Cornell Medical College and the St. Giles Assistant Professor of Pediatric Retina at Weill Cornell Medical College. Dr. Chan states that he has no financial interests or relationships to disclose. He may be reached at +1 646 962 2540; or via e-mail at roc9013@med.cornell.edu.

Donald J. D’Amico, MD, is Professor and Chairman of the Department of Ophthalmology at Weill Cornell Medical College and Ophthalmologist-in-Chief at New York-Presbyterian Hospital, New York, NY. Dr. D’Amico states that he is consultant for Alcon Laboratories and Neurotech, and a scientific advisory board member and equity holder in OptiMedica, Ophthotech, and Jerini Ophthalmic.

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