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SURGICAL TREATMENT FOR SEVERE DIABETIC MACULAR EDEMA WITH MASSIVE HARD EXUDATES

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Purpose: Massive diabetic macular exudates respond poorly to conventional laser treatment. The purpose of this study was to analyze the surgical results of eyes with massive hard exudates secondary to diabetic macular edema treated with combined pars plana vitrectomy, posterior hyaloid removal, focal endolaser treatment, and panretinal photocoagulation.

Methods: The author retrospectively analyzed the surgical outcome of 13 consecutive eyes (11 patients) with massive diabetic macular exudates. All patients had had at least one session of focal and/or grid laser treatment without any effect. Pars plana vitrectomy, posterior hyaloid removal, focal macular endolaser treatment, and intraoperative panretinal photocoagulation were performed. Postoperative visual acuity, evolution of macular edema, and hard exudates were recorded.

Results: All 13 eyes showed significant decreases in macular edema and hard exudates, a process that became clinically obvious 3 months after the operation. Eleven eyes had improved vision of at least two lines during an average follow-up period of 14.8 months. Intraoperative and postoperative complications included angle closure glaucoma (one eye), persistent vitreous hemorrhage (two eyes), choroidal detachment (one eye), intravitreal fibrin formation (one eye), epiretinal membrane formation (one eye), and neovascular glaucoma (one eye).

Conclusion: Combined surgery may offer an opportunity for improvement of vision and reduction of massive macular exudates in patients with severe diabetic macular edema.

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Macular edema is an important cause of visual impairment in patients with diabetic retinopathy.[1,2] When clinically significant macular edema develops, fluorescein angiogram–guided focal and/or grid laser photocoagulation has been the standard treatment to stabilize vision.[3] The edema may sometimes become very severe and cause diffuse thickening of the retina with excessive, confluent, hard exudates in the posterior pole, reducing vision tremendously. Laser treatment has little ability to improve such severe edema.

Recently, pars plana vitrectomy with removal of undetached taut posterior hyaloid membrane has been advocated to treat macular edema that is unresponsive to conventional laser therapy.[4,5] Removal of the more transparent premacular posterior hyaloid has also been shown to benefit eyes with diffuse macular edema.[6] These findings support the postulation that the vitreous may play a role in the formation or exacerbation of diabetic macular edema.[7,8] However, the functional and anatomic outcome of surgical excision of the posterior hyaloid in severe macular edema accompanied by massive and confluent hard exudates is uncertain.

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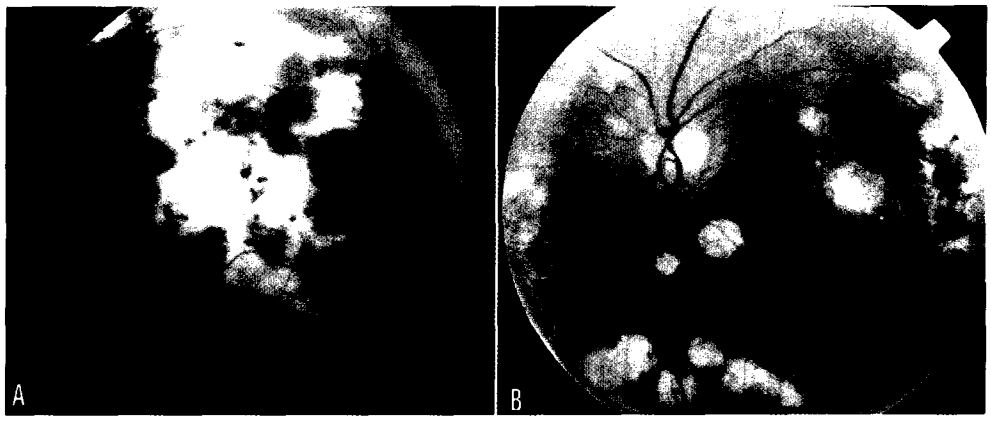

Fig. 1. A, Preoperative fundus photograph of a patient (Case 5) with severe macular edema and confluent hard exudates. **B,** Fundus photograph of the same patient 12 months after operation shows resolution of hard exudates. There are crystallike deposits in the central fovea.

In addition to systemic factors such as hypertension, renal diseases, and hyperlipidemia, at least three local factors may contribute to severe macular edema and hard exudates: 1) excessive fluid leakage from microaneurysms, capillary segments, or arterioles; 2) tangential or vertical vitreous traction; and 3) vascular leakage from early fibrovascular proliferation. This study sought to determine whether surgical removal of the undetached posterior hyaloid, taut or loose, combined with macular focal and peripheral scattered endolaser treatment can improve the anatomic and functional outcome in eyes with massive hard exudates secondary to diabetic macular edema.

Patients and Methods

From January 1997 to December 1998, 13 consecutive eyes of 11 patients (eight men and three women) undergoing operation for severe diabetic macular hard exudates were recruited for study. All patients met the following criteria: 1) visual acuity (VA) less than 20/100 in the operated eyes, 2) massive hard exudates involving the fovea with diffuse thickening of the posterior pole, 3) at least one session of laser treatment attempted without any noticeable effect, and 4) regular control of preexisting hyperlipidemia or hypertension by internists. Eyes with a detached posterior hyaloid were excluded from the study.

Patient age ranged from 52 to 75 years. The postoperative follow-up period ranged from 6 months to 32 months, with an average of 14.8 months. Three eyes in three patients had proliferative diabetic retinopathy and had received panretinal photocoagulation (PRP) before the current operation. All patients had complete ophthalmologic examinations including best-corrected VA and intraocular pressure measurement, biomicroscopic examination of the anterior and posterior segment, and indirect ophthalmoscopic fundus examination. Fluorescein angiography was routinely performed before the operation.

The operation consisted of pars plana vitrectomy, removal of the posterior hyaloid, focal endolaser treatment to hyperpermeable capillary segments and clusters of microaneurysms, and moderate PRP in previously untreated eyes and supplementary PRP in previously treated eyes. Leaking large vessels were not treated. Lens extraction, mainly by phacoemulsification, was performed when cataract existed before the operation. For taut and thickened posterior hyaloid, a barbed microvitreoretinal blade was used to engage and lift the hyaloid membrane in the macular area; for loose and transparent posterior hyaloid, active suction of the membrane above the disk using vitreous cutter was performed to induce posterior vitreous detachment (PVD). Evolution of the macular edema, hard exudates, and change in VA were specifically noted during the follow-up period.

Results

Preoperative fluorescein angiography showed that all eyes contained multiple areas of focal leakage from clusters of microaneurysms and diffuse leakage from dilated vascular segments, indicating inner blood–retinal barrier breakdown. A transient increase in macular thickening without increase of exudates was noted in all eyes within the first 2 weeks after the operation. Obvious reduction of hard exudates was noticed approximately 3 months after the operation. The confluent plaque of hard exudates broke down into small pieces, reduced in size and thickness, and then gradually disappeared. Residual, persistent shining submacular deposits were seen in two eyes after reabsorption of most of the exudates.

All 13 eyes showed significant reduction of hard exudates and macular edema at the end of follow-up (Figure 1, A and B). Visual acuity improved in 11 and

Table 1. Patient Characteristics

Case No.	Sex	Age, yr	Eye	Preop VA	Postop VA	Postop Cx	Follow-up (mo)
1	M	59	OS	20/1000	20/400		6
2	F	75	OS	20/1000	20/400		22
3	M	60	OD	CF	20/400	Glaucoma	6
4	M	60	OD	20/400	20/1000	VH, CAT	32
5	M	56	OS	CF	20/200		17
6	M	61	OD	20/1000	20/400	ERM	13
7	F	63	OD	CF	20/1000	Fibrin	8
8	M	62	OD	CF	20/1000		6
9	M	61	OS	CF	HM	CD, NVG	22
10	M	61	OD	CF	20/200		12
11	M	57	OS	20/800	20/200		11
12	M	57	OD	20/2000	20/200		7
13	M	52	OS	CF	20/400	VH	30

VA, visual acuity; Cx, complication; OS, left eye; OD, right eye; CF, counts fingers; VH, vitreous hemorrhage; CAT, cataract; ERM, epiretinal membrane; HM, hand motions; CD, choroidal detachment; NVG, neovascular glaucoma.

decreased in two eyes. The causes of decrease in VA were progressive cataract in one eye and neovascular glaucoma that developed 10 months after the operation in the other. Intraoperative vitreous hemorrhage was noted in one eye. Postoperative complications included pupillary block glaucoma in one eye, neovascular glaucoma in one eye, persistent vitreous hemorrhage in two eyes, choroidal detachment in one eye (which later developed neovascular glaucoma), intravitreal fibrin formation in one eye, and epiretinal membrane in one eye. The clinical data are summarized in Table 1. A representative case is presented below.

Case Presentation

A 56-year-old man first visited our clinic in February 1998 complaining of bilateral blurred vision. He had had diabetes mellitus for more than 10 years. Blood sugar had been controlled by oral hypoglycemic agents. Ophthalmologic examination revealed that best-corrected VA was 20/400 in both eyes. Fluorescein angiography showed severe vascular leakage in the posterior pole in both eyes. An area of extensive nonperfusion was noted. Combined focal and grid laser treatment was performed in both eyes without effect. Visual acuity decreased progressively. Within 4 months, excessive hard exudates with confluent yellow plaque were noted in his left eye (Figure 2A). Visual acuity had decreased to 20/800. Pars plana vitrectomy with removal of the posterior hyaloid, focal endolaser treatment, and PRP were performed in the left eye in June 1998. Significant decrease of hard exudates was noted 3 months later, and VA improved to 20/200 11 months after the operation (Figure 2B). The right eye also showed progression of hard exudates and VA dropped to 20/2000 (Figure 2C). A similar operation was performed in the right eye in October 1998; 7 months later, VA had improved to 20/200. There was significant clearing of hard exudates (Figure 2D).

Discussion

Hard exudates are lipidic and proteinaceous material deposited in the outer retina and, sometimes, the subretinal space. This is a sign of increased vascular permeability and breakdown of the blood–retinal barrier. A report from the Early Treatment of Diabetic Retinopathy Study Group showed that increasing amounts of exudate appear to be independently associated with an increased risk of visual impairment.[9] Massive macular exudates may impair VA severely, and they are refractory to conventional laser treatment. In this report, 13 eyes from 11 patients with severe macular edema with confluent hard exudates were treated with pars plana vitrectomy, focal laser treatment, and PRP. All eyes showed a significant decrease of the edema and reduction of the exudates. Vision improved in 11 eyes. This retrospective study had certain limitations: there was no control group, no standard VA testing was required, and there was no defined protocol for combined cataract surgery. Nonetheless, these findings suggest the effectiveness of surgical procedures for the treatment of excessive hard exudates secondary to macular edema.

Studies have shown the close relationship between the vitreous, especially the posterior hyaloid, and diabetic macular edema. Hikichi et al[8] demonstrated that vitreomacular separation may promote the spontaneous resolution of diabetic macular edema. Nasrallah et al[7] showed that diabetic eyes with macular edema have a lower rate of PVD than those without macular edema, and speculated on a possible role of the vitreous in the pathogenesis of diabetic macular edema. Lewis et al[4] found that vitrectomy with removal of the thickened, taut premacular posterior hyaloid resulted in reduced macular edema and improved VA. Tachi and Nobuchika[6] further noted that the removal of loose posterior hyaloid also had a significant effect on the reduction of macular edema. The vitreous may behave as a reservoir of inflammatory substances and

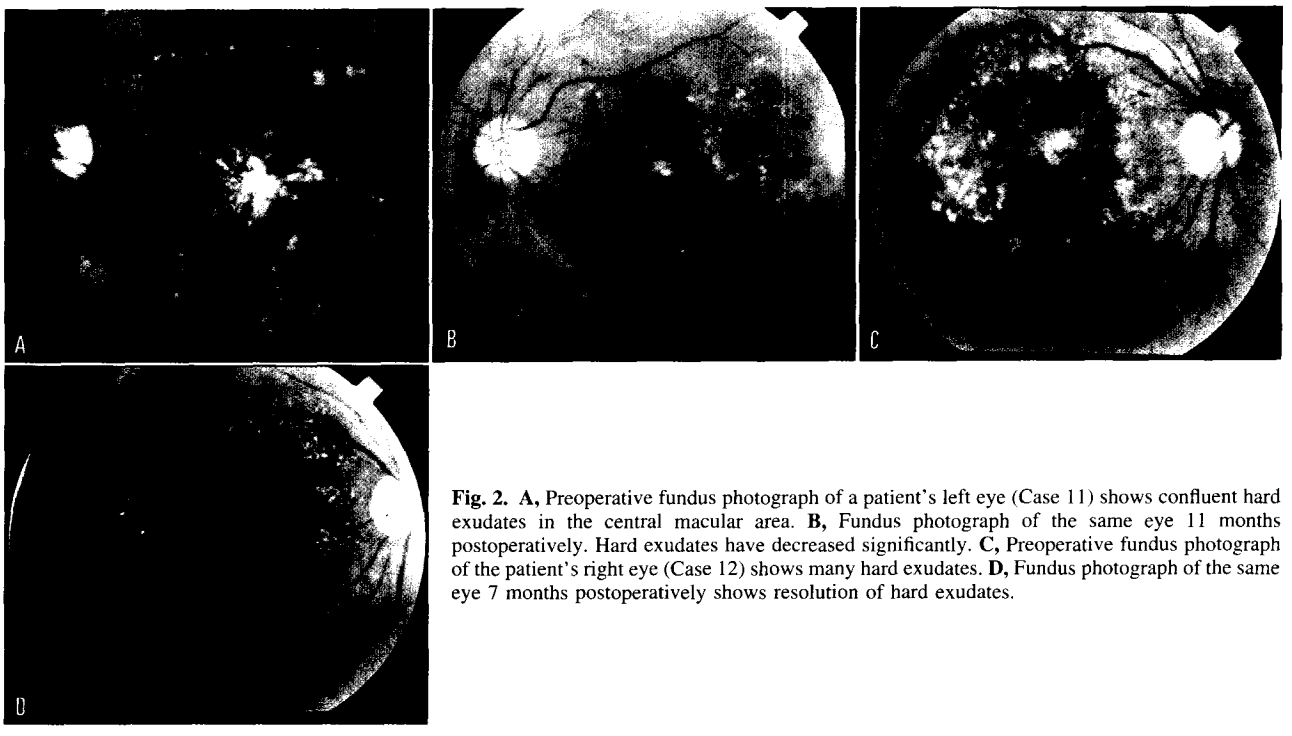

Fig. 2. A, Preoperative fundus photograph of a patient's left eye (Case 11) shows confluent hard exudates in the central macular area. **B,** Fundus photograph of the same eye 11 months postoperatively. Hard exudates have decreased significantly. **C,** Preoperative fundus photograph of the patient's right eye (Case 12) shows many hard exudates. **D,** Fundus photograph of the same eye 7 months postoperatively shows resolution of hard exudates.

its cortex may be a source of tangential traction on the retinal vessels. Vitrectomy may serve the dual purpose of removal of the inflammatory substance and release of the tangential traction.

Although it is possible that removal of the posterior hyaloid alone may decrease hard exudates, we routinely performed PRP for the following reasons. First, as evidenced in two cases in this series, vitreous hemorrhage, presumably associated with neovascularization, may occur postoperatively, preventing adequate fundus examination and timely PRP treatment. This complication may justify intraoperative PRP to stabilize the eye. Secondly, extensive nonperfusion and subtle neovascularization may have been present before surgery. Intraoperative PRP may prevent the advance of retinopathy and the development of rubeosis and neovascular glaucoma. Third, as indicated by Tachi,[10] macular edema aggravated by PRP responds well to vitrectomy and posterior hyaloid removal, indicating that vitreous traction may be an important factor for development of post-PRP macular edema. Moderate intraoperative PRP in the absence of posterior hyaloid may not exacerbate macular edema as significantly as when the posterior hyaloid is present. Finally, the long-term effect of PRP is constriction of retinal vessels and decrease in leakage from vascular segments. These changes may be beneficial for the reduction of macular edema.

Although focal treatment before the operation was ineffective in all cases and laser spots are difficult to obtain, it was easy to get a grade I to II laser burn with intraoperative endophotocoagulation. Focal treatment is believed to act by reducing vascular permeability or increasing active fluid transport by the retinal pigment epithelium. Tachi,[10] in his study on management of macular edema, performed focal laser treatment 2 or 3 months after surgical removal of the posterior hyaloid. Although greater laser energy may be required when severe edema is present, intraoperative focal treatment is convenient, precise, and not influenced by postoperative media opacity, which may delay or prevent timely and adequate focal laser treatment.

After the operation, short-term increased thickening of the macular area was noted. However, in this series, after 2 to 3 months, the amount of hard exudates had decreased significantly. In severe cases, persistent crystallike submacular deposits may be seen after reabsorption of most of the exudates. None of our patients had recurrence of hard exudates after the procedure. It should be noted that not all eyes with severe diabetic hard exudates had attached posterior hyaloid. Diabetic macular edema in the presence of PVD precludes vitreous tangential traction as an important element inducing vascular permeability changes. Systemic factors such as hyperlipidemia, renal disease, or cardiovascular diseases may significantly contribute to producing severe macular edema. Whether vitrectomy combined with intraoperative fo-

cal and peripheral scattered endolaser treatment will decrease edema and exudates in this setting is not known.

In this study, VA did not improve to better than 20/200 in any patient during the follow-up period, even though the appearance of the ocular fundi greatly improved. This result suggests that massive hard exudates may cause irreversible damage to visual function, or that their presence may indicate a compromised macula. The prevention of hard exudate accumulation may be important in order for diabetic patients to maintain good VA.

Recently, subretinal removal of massive subfoveal hard exudates was shown to increase VA.[11] However, the procedure may be complicated by macular hole formation and neurosensory retina damage. We believe that the technique we describe here should be tried first. Further procedures should be undertaken only if the current procedure fails to decrease subfoveal exudates and improve VA.

In summary, it is highly unlikely that conventional laser treatment will improve VA in patients with severe diabetic macular edema and confluent exudates. The surgical technique described here—combined pars plana vitrectomy, posterior hyaloid removal, intraoperative focal laser treatment, and panretinal photocoagulation—offers an opportunity to reduce hard exudates and improve vision to some degree.

Key words: diabetic macular edema, hard exudates, pars plana vitrectomy, panretinal photocoagulation.

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