

Vitrectomy Combined with Phacoemulsification and Intraocular Lens Implantation for Diabetic Macular Edema

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Purpose: The outcome of vitrectomy combined with phacoemulsification and intraocular lens implantation (PEA+IOL) for diabetic macular edema was evaluated.

Methods: Included in this study were 31 patients (42 eyes) with clinically significant diabetic macular edema, in whom posterior vitreous detachment was not observed. Pars plana vitrectomy combined with PEA+IOL was performed on 15 eyes. Sixteen phakic eyes and 11 pseudophakic eyes were followed up without vitrectomy as controls. Visual acuity and the state of macular edema were evaluated.

Results: After follow-up of 18 ± 7 (mean \pm SD) months, clinically significant macular edema remained in 3 eyes (20%) of the vitrectomy group, in 11 eyes (69%) of the phakic control group, and in 9 eyes (82%) of the pseudophakic control group. The logarithm of the minimal angle of resolution (Log_{MAR}) of the best-corrected visual acuity of the vitrectomy group eyes significantly improved from 1.09 ± 0.27 to 0.80 ± 0.35 ($P < .01$), while that of pseudophakic control eyes significantly decreased from 0.59 ± 0.17 to 0.86 ± 0.28 ($P < .05$). The Log_{MAR} of phakic control eyes also decreased from 0.82 ± 0.36 to 0.93 ± 0.30 , but there was no significant difference ($P = .19$).

Conclusion: Vitrectomy combined with PEA+IOL is an effective surgical modality to improve visual acuity in eyes with clinically significant diabetic macular edema. **Jpn J Ophthalmol** 2002;46:455–459 © 2002 Japanese Ophthalmological Society

Key Words: Diabetic retinopathy, intraocular lens implantation, macula edema, phacoemulsification, vitrectomy.

Introduction

It has been reported by the Early Treatment Diabetic Retinopathy Study (ETDRS) that focal laser photocoagulation induces beneficial effects on diabetic macular edema patients by reducing the risk of moderate visual loss by 50%.^{1–4} Macular edema sometimes becomes very severe and persists long after the photocoagulation treatment,^{1–4,5} and for such cases with persistent diabetic macular edema, the effectiveness of vitrectomy in improving visual acuity

has been reported.^{6–10} Although the pathogenesis of macular edema is not well understood, it has been postulated in these reports that the removal of posterior vitreous may have had a beneficial effect on the macular edema by releasing the vitreoretinal traction. Cataracts often progress in diabetic patients and impair visual acuity. However, diabetic retinopathy is more likely to worsen in cataract-operated eyes than in eyes without an operation.^{11,12} Therefore, in this study, we evaluated the outcome of a pars plana vitrectomy combined with phacoemulsification and intraocular lens implantation (PEA+IOL) for diabetic macular edema in eyes without posterior vitreous detachment. We compared the results in these eyes with results in the control eyes without vitrectomy.

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Patients and Methods

This retrospective study was comprised of 42 eyes of 31 patients (17 men and 14 women) with clinically significant diabetic macular edema,¹ in whom posterior vitreous detachment was not observed. Posterior vitreous detachment was diagnosed by the existence of a Weiss ring. Proliferative diabetic retinopathy was evident in all of the included eyes, and panretinal photocoagulation had been performed before entry into this study. Diagnosis of clinically significant diabetic macular edema was made by a stereo slit-lamp biomicroscopic examination with a 90-diopter lens and/or contact lens, as described previously, and fundus photographs were taken.¹⁻⁴ Clinically significant macular edema was defined if at least one of the following characteristics was present: thickening of the retina at or within 500 microns of the center of the macula; hard exudates at or within 500 microns of the center of the macula if associated with thickening of the adjacent retina; a zone or zones of retinal thickening 1 disc area or larger, any part of which is within 1 disc diameter of the center of the macula.¹

Fluorescein angiography at the start of this study showed a diffuse pattern of leakage in the macula of all the eyes. If there was fluorescein leakage without retinal thickening, it was not considered to be macular edema. Although fluorescein fundus angiography was performed in all cases, macular edema was mainly diagnosed by stereo biomicroscopy, because an increase in retinal thickness and associated loss in visual acuity may occur without detectable fluorescein leakage.¹⁰ Thickened and taut premacular posterior hyaloid was observed in 1 eye of the vitrectomy group and in 1 eye of the control group.^{7,8}

The controls in this study were those diabetic patients who refused further photocoagulation including grid photocoagulation.^{1,2,13,14} Focal macular photocoagulation had been performed on all the eyes of control group and 2 eyes of vitrectomy group. The mean (\pm SD) interval between photocoagulation and entry into this study was 4 ± 1 months (range, 1-6 months). The patients in the vitrectomy group were those who consented to the surgery after hearing an explanation of the results of vitrectomy for macular edema.^{6-9,15} Informed consent was obtained from all participants in the study. Vitrectomies were conducted between October 1996 and May 1999 at Tenri Yorozu Hospital (Nara).^{6-9,15}

Twelve patients (15 eyes) underwent a pars plana vitrectomy with PEA+IOL (vitrectomy group). In 27 eyes of 19 patients, no vitrectomy was performed (control group). Among the control eyes, 16 eyes of

13 patients had no surgical history (phakic control group), and 11 eyes of 7 patients had undergone PEA+IOL before entering this study (pseudophakic control group). In this pseudophakic group, the mean interval between cataract surgery and the entry to this study was 24 ± 32 months (range, 2-85 months). The mean age of the patients in the vitrectomy group, phakic control group, and pseudophakic control group was 62 ± 10 (range, 39-73), 61 ± 11 (range, 39-75), and 68 ± 9 years (range, 56-84), respectively. There was no significant difference in age distribution among the three groups.

The mean follow-up period of all patients was 18 ± 7 months (range, 9-30 months). The mean follow-up period of the vitrectomy group, phakic control group, and pseudophakic control group was 18 ± 7 (range, 10-27), 17 ± 7 (range, 9-30), and 19 ± 6 months (range, 9-27), respectively. The follow-up period of the vitrectomy group was the same as the follow-up period after surgery. There was no significant difference in the follow-up period among the three groups.

In the vitrectomy group, both phacoemulsification and intraocular lens implantation were done as a combined surgical procedure. In all cases of the vitrectomy group, slit-lamp examinations showed mild cataracts before surgery. Those cases with a moderate to severe cataract, which interfered with the evaluation of macular edema, were excluded from this study. After the usual phacoemulsification and aspiration procedures, an acrylic foldable intraocular lens was implanted through a 3.5-mm self-sealing scleral wound. Pars plana vitrectomy was performed in a routine manner. The posterior hyaloid was separated by suction from the optic disc and macula, then the peripheral hyaloid was detached by suction or mechanical peeling using a vitreoretinal pick and/or forceps. The vitreous was resected with a vitreous cutter.

Snellen visual acuity was converted to logarithms of the minimal angle of resolution (Log_{MAR}) values for analysis.¹⁶ An improved or worsened visual acuity was defined as when there was a change of two or more lines of the best-corrected Log_{MAR} visual acuity.

Statistical analyses were done using a paired *t*-test, one-way analysis of variance (ANOVA), or Fisher's protected least significant difference (Fisher's PLSD) for a post-hoc test. $P < .05$ were considered significant.

Results

At the last examinations, stereo slit-lamp biomicroscopic examinations showed that clinically signifi-

cant macular edema remained in 3 eyes (20%) of the vitrectomy group, in 11 eyes (69%) of the phakic control group, and in 9 eyes (82%) of the pseudophakic control group.

Of the 15 eyes in the vitrectomy group, the best-corrected visual acuity improved at least two lines in 11 eyes (73%), remained unchanged in 3 eyes (20%) and worsened in at least two lines in 1 eye (7%) (Figure 1). Of the 16 eyes in the phakic control group, the best-corrected visual acuity improved in 3 eyes (19%), remained unchanged in 5 eyes (31%), and worsened in 8 eyes (50%) (Figure 2). Of the 11 eyes in the pseudophakic control group, the best-corrected visual acuity remained unchanged in 7 eyes (64%), and worsened in 4 eyes (36%) (Figure 2). Obvious secondary cataract was not observed in any of the pseudophakic control eyes and vitrectomy group eyes at the last examination. The mean Log_{MAR} of the best-corrected visual acuity in the eyes of the vitrectomy group, phakic control group, and pseudophakic control group at the beginning of this study was 1.09 ± 0.27 , 0.82 ± 0.36 , and 0.59 ± 0.17 , respectively. Upon entering this study, the mean Log_{MAR} of the best-corrected visual acuity in the eyes of the vitrectomy group was significantly worse than that of the phakic control group (Fisher's PLSD, $P < .05$), or pseudophakic control group (Fisher's PLSD, $P < .01$). At final examinations, the mean Log_{MAR} of the best-corrected visual acuity in

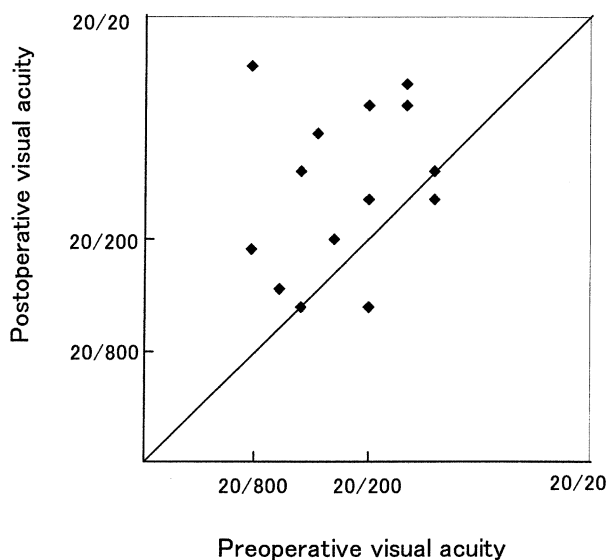


Figure 1. Preoperative and final postoperative visual acuities in the vitrectomy combined with phacoemulsification and intraocular lens implantation group of diabetic macular edema patients.

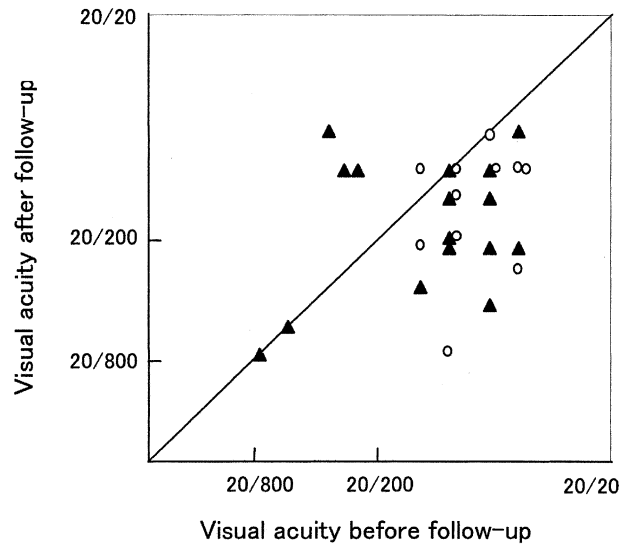


Figure 2. Visual acuities of the control groups before and after follow-up. ▲ phakic eye, ○ pseudophakic eye.

the eyes of the vitrectomy group, phakic control group, and pseudophakic control group was 0.80 ± 0.35 , 0.93 ± 0.30 , and 0.86 ± 0.28 , respectively. There were no significant differences in the final Log_{MAR} of the best-corrected visual acuity among the three groups [ANOVA; $F(2,39) = 0.66$, $P = .52$]. The mean Log_{MAR} of the best-corrected visual acuity in the eyes of the vitrectomy group significantly improved after surgery (paired t -test, $P < .01$), while that of the pseudophakic control group significantly worsened after the follow-up periods (paired t -test, $P < .05$). The mean Log_{MAR} in the eyes of the phakic control group also worsened after the follow-up periods, but there was no statistical difference (paired t -test, $P = .19$).

Complications in the vitrectomy group included intraoperative retinal tears in 2 eyes, a postoperative vitreous hemorrhage in 1 eye, and the onset of neovascular glaucoma in 1 eye.

Discussion

Recent studies have reported beneficial effects of vitrectomy for diabetic macular edema with and without focal photocoagulation.^{6-9,15} In these studies, pars plana vitrectomy was performed in the eyes of patients without posterior vitreous detachment. Therefore, in this study, we selected the cases without posterior vitreous detachment to evaluate the outcome of pars plana vitrectomy combined with cataract surgery in patients with diabetic macular edema. We

performed a combined surgical procedure of phacoemulsification, intraocular lens implantation, and vitrectomy because postoperative progression of cataracts is inevitable in elderly patients,^{17,18} and because an anterior proliferation resulting from an incomplete anterior vitreous resection may occur in a phakic eye after surgery.¹⁹

In this study, the percentage of the cases with residual clinically significant macular edema was smaller in the vitrectomy group than in the control groups at last examinations. These results showed that the combined surgery of vitrectomy+PEA+IOL produced a beneficial effect for patients with diabetic macular edema. Although the mechanism of the effect of vitrectomy for diabetic macular edema has not been well understood, the most important difference between the eyes of the vitrectomy group and the control groups should be the presence of vitreous. The breakdown of the blood—retinal barrier in diabetic eyes was recognized by fluorophotometric studies.^{20,21} Inflammatory chemical mediators and cytokines produced near the macula may easily be dispersed after the vitrectomy and as a result, the macular edema may be decreased. Another possible explanation concerning the mechanism of vitrectomy in decreasing diabetic macular edema may be the release of tangential macular traction by vitreous.^{6,8,9} Posterior vitreous detachment was not observed in any cases before entry to this study. Although obvious thickened and taut premacular posterior hyaloid was observed in only 1 eye of the vitrectomy group, the possibility that an artificial posterior vitreous detachment was the main cause of the improvement of macular edema cannot be denied. However, because there were several cases in our control group in which macular edema was decreased without posterior vitreous detachment, it seems that the macular edema was not related to mechanical vitreous traction in all cases. The performance of a vitrectomy on eyes with diabetic macular edema will relieve the above-mentioned mechanisms related to the onset and/or progression of diabetic macular edema.

A recent study reported that vitrectomy including removal of the inner limiting membrane led to the resolution of diffuse macular edema.⁶ They concluded that complete release of tractional forces and inhibition of re proliferation of fibrous astrocytes seem to be prudent. The removal of the inner limiting membrane was effective even for the vitrectomy eyes.⁶ In our study, clinically significant macular edema was still observed in 20% of the cases in the vitrectomy group at final examinations. In these

cases the re proliferation of fibrous astrocytes may have occurred during the follow-up period. The removal of the inner limiting membrane may have to be performed as a next strategy in these cases.

The best corrected-visual acuity of the vitrectomy group upon entry into this study was significantly worse than in the control groups. The more severe cases of macular edema were included in the vitrectomy group rather than in the control groups. Nonetheless, the visual acuity of the eyes of the vitrectomy group showed statistically significant improvement after surgery, while the visual acuity in the control groups worsened during the follow-up periods. The difference in the prognosis of the visual acuity may not be due only to the decrease of macular edema, but may be due in part to the cataract operation. However, the best-corrected visual acuity in the vitrectomy group was better than that of the control groups at final examinations, showing that the combined surgery of vitrectomy+PEA+IOL is an encouraging surgical modality.

On the other hand, the visual acuity of the cataract-operated eyes without vitrectomy in the control group significantly worsened after follow-up, indicating that the performance of cataract surgery might be involved in the decrease of the visual acuity. This result is consistent with previous reports that have shown that diabetic retinopathy is more likely to worsen in cataract-operated eyes than in eyes without an operation.^{11,12} In the cataract-operated eyes, postoperative inflammation or breakdown of the blood—retinal barrier may have accelerated the edema and damaged the macula.^{22,23} Our results indicate that the visual prognosis of cataract surgery without vitrectomy for the eyes with macular edema is poor. In the case of an eye with macular edema and with cataract, the preferred surgery may be the combined surgery of a cataract operation and a vitrectomy rather than just cataract surgery alone. Future research with a larger number of cases will be needed to confirm the above hypothesis.

Complications in the vitrectomy group were peripheral retinal tears in 2 eyes, which were treated by intraoperative photocoagulation, a vitreous hemorrhage in 1 eye, which needed a vitrectomy, and neovascular glaucoma in 1 eye. The removal of the lens enables us to intensively remove peripheral vitreous and add laser photocoagulation in the most peripheral retina. Also, because the progression of a nuclear cataract is a serious postoperative complication after a vitrectomy, the combined surgery of vitrectomy and PEA+IOL will prevent a decrease of visual acuity by the onset and progression of cataracts.

Thus, our results, in addition to the above-mentioned merits, demonstrated the usefulness of the combined surgical procedure of vitrectomy and PEA+IOL even for the treatment of diabetic macular edema. However, the number of cases in this study was small, so further investigation with a larger number of patients for a controlled study will be needed to ascertain the effects of the combined procedure of vitrectomy and PEA+IOL on diabetic macular edema patients with cataracts.

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