# PREDICTIVE FACTORS OF VISUAL OUTCOME FOR VITREOMACULAR TRACTION SYNDROME AFTER VITRECTOMY



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**Purpose:** To assess the long-term functional and anatomical outcomes for vitreomacular traction syndrome (VMT) after vitrectomy and to analyze the predictive factors regarding visual outcome.

**Methods:** A retrospective, consecutive case series of 22 eyes in 22 patients with VMT who underwent vitrectomy to relieve macular edema were studied. Eyes were classified into two groups according to the diameter of vitreomacular adhesion based on spectral domain optical coherence tomography: Group 1 (14 eyes) focal attachment $\leq$1,500 $\mu$m; and Group 2 (eight eyes) broad attachment $>$1,500 $\mu$m.

**Results:** Mean postoperative follow-up was 25.4 months (range, 6–68). The preoperative mean logarithm of the minimal angle of resolution visual acuity was 0.73 (20/107), which significantly improved to 0.49 (20/62) postoperatively ($P < 0.01$). Seventeen eyes (77%) had Snellen visual acuity improvement ≧ two lines, and nine eyes had improvement ≧ three lines. The improvement of visual acuity was significantly better in Group 1 than in Group 2 (2.7 lines vs. 0.8 lines) ($P = 0.03$). The preoperative mean central macular thickness was 563 $\mu$m ± 176 $\mu$m, which significantly improved to 298 $\mu$m ± 69 $\mu$m postoperatively ($P < 0.01$). In multivariate analysis, better final visual acuity was significantly associated with Group 1 VMT ($P < 0.01$) and with shorter symptom duration ($P < 0.01$). Greater improvement of visual acuity was also significantly associated with younger age of patients ($P = 0.02$) and with Group 1 VMT ($P < 0.01$). In linear regression analysis, patients with longer symptom duration had worse final visual acuity ($\beta = 0.02$) and patients of younger age had greater visual acuity improvement ($\beta = 0.008$).

**Conclusion:** Most patients of VMT gained significant functional and anatomical improvements after vitrectomy. Group 1 optical coherence tomography pattern, shorter symptom duration, and younger age are significant predictive factors of better visual outcome.

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Posterior vitreous detachment (PVD) is an aging process in humans.[1,2] Vitreomacular traction syndrome (VMT) is an idiopathic disorder associated with incomplete PVD. Persistent vitreous macular traction may lead to ocular symptoms such as blurred vision, photopsia, micropsia, or metamorphopsia.[3] In the natural course of VMT, approximately 11% to 32% of patients regain vision and symptom relief spontaneously in long-term follow-up.[4–7] Some symptomatic patients with persistent VMT may undergo further progression into macular hole, persistent macular edema, foveal detachment, macular atrophy, and severe deterioration of visual function and quality of life.[6,8]

The treatment options of symptomatic VMT include observation, pneumatic vitreolysis, intravitreal ocriplasmin injection, and pars plana vitrectomy. Ocriplasmin is a recombinant protease enzyme that degrades laminin and fibronectin and releases and

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resolves the vitreoretinal adhesion in VMT.[9] However, there are several contraindications for the candidates of intravitreal ocriplasmin, such as epiretinal membrane, high myopic eye, or broad width of VMA.[9,10] Furthermore, the resolution rate of VMT was only 26.5% during a 28-day follow-up period.[9] Also, ocriplasmin may have resulted in several severe ocular adverse effects, including retinal tear and detachment,[9] temporary ellipsoid zone attenuation,[11] reduced visual acuity, vitreous floaters,[12] macular hole enlargement, macular detachment, dyschromatopsia and nyctalopia, and lens subluxation.[13] Pneumatic vitreolysis using intravitreal injection of hexafluorosulfide ($SF_6$) or perfluoropropane ($C_3F_8$) gas was reported to be effective or superior to nonsurgical treatment options for VMT.[14,15]

Vitrectomy had been advocated and has become the mainstay surgical treatment for VMT in recent years.[16,17] However, the variation of visual outcome in VMT after vitrectomy indicates that there might be other influencing factors present in different VMT subtypes.[18,19] Anatomical configuration of VMT may have clinical implications on surgical outcome. Different tomographic presentations of VMT have been described.[18] The spectral domain optical coherence tomography (SD-OCT) imaging system, featuring an axial resolution of 5 $\mu$m and scanning speed of up to 40,000 A-scans per second, is more sensitive than slit-lamp biomicroscopy. Optical coherence tomography has provided a facilitative tool for identifying vitreoretinal adhesion details associated with VMT before operation.[20] Eyes of VMT may be subclassified into two groups according to the diameter of vitreomacular adhesion based on SD-OCT: focal attachment $\leq$1,500 $\mu$m or broad attachment $>$1,500 $\mu$m.[21] Different types of VMT may have inherently different visual outcomes which need further study to elucidate.

The purpose of this study was to assess the long-term functional and anatomical outcomes in eyes with VMT after vitrectomy, and to analyze the possible predictive factor regarding the surgical outcome of VMT. In this study, we highlighted the different patterns of VMT determined by SD-OCT and its correlation with visual outcome.

## Patients and Methods

### *Study Design*

A retrospective, interventional study was conducted to evaluate consecutive patients with idiopathic VMT who underwent pars plana vitrectomy from 2008 to 2015. This study was approved by the Institutional Review Board at the Taipei Veteran General Hospital, and all the data were collected within the tenets of the Declaration of Helsinki. Inclusion criteria were patients with VMT who underwent vitrectomy to relieve macular edema. Demographic data of patients and ocular parameters before and after operation were collected. Patients with a minimum of 6-month follow-up were included. Exclusion criteria included patients with previous vitreoretinal surgeries, treated retinal breaks, uveitis, inadequate documentations, and poor quality of OCT image.

### *Patients*

Eyes with the diagnosis of VMT had persistent vitreomacular traction by biomicroscopy examination, causing central visual impairment of metamorphopsia and blurred vision. The associated ocular signs included partial vitreous detachment, distortion of fovea contour, cystoid macular edema, epiretinal macular thickening, and foveal detachment.

### *Ocular Examination and High-Resolution Optical Coherence Tomography*

All patients underwent complete ophthalmologic examination before and after vitrectomy surgery, including measurements of Snellen best-corrected visual acuity (BCVA), intraocular pressure, slit-lamp biomicroscopy, color fundus photography, and indirect ophthalmoscopy. The Snellen visual acuity was converted to the logarithm of the minimal angle of resolution (LogMAR) for statistical analysis and comparison.

The OCT examination was performed using SD-OCT device (OptoVue, Fremont, CA) with raster scans which consisted of five parallel B-scans 6 mm in length, and reference thickness scans. The central macular thickness (CMT) before and after surgery were calculated automatically in the reference thickness scans.

All the subjects were further subclassified into two groups according to the anatomical pattern of VMT shown in SD-OCT examination (the International Vitreomacular Traction Study Group classification).[21] Group 1 was defined as VMT with focal attachment with vitreomacular adhesion (VMA) less than 1,500 micrometers ($\mu$m) in width in OCT. Group 2 was defined as broad attachment with VMA more than 1,500 $\mu$m in width in OCT (Figure 1).

### *Surgical Procedures*

All the surgeries were performed by two retinal surgeons (C.S.Y. and S.J.C.) at the Department of Ophthalmology in Taipei Veteran General Hospital. All surgical procedures included the following steps: 23-gauge pars plana vitrectomy setting, core vitrectomy, removing all anterior-posterior vitreous traction under the aid of triamcinolone acetonide, and forceps

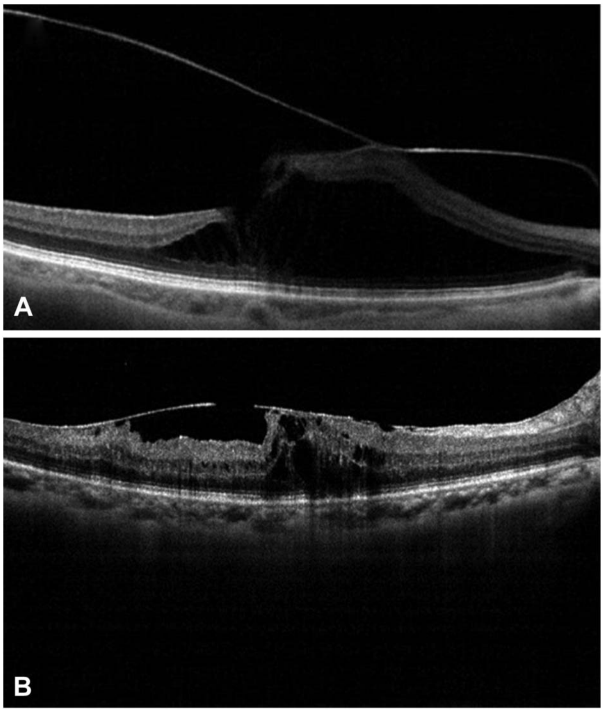


**Fig. 1.** Eyes with VMT were subclassified into two groups according to the diameter of vitreomacular adhesion based on SD-OCT. **A.** Focal type (Group 1) represents focal adhesion ≤1,500 $\mu$m, showing intraretinal cystoid edema and tractional macular schisis. **B.** Broad type (Group 2) represents broad adhesion >1,500 $\mu$m, showing adherent epiretinal membrane, macular thickening, and foveal detachment.

peeling of all adherent posterior cortical vitreous or any epiretinal membrane at macula. The use of indocyanide green dye–assisted peeling of internal limiting membrane (ILM) was according to surgeon's discretion. Sulfur hexafluoride gas tamponade was performed at end of surgery if there was significant retinal wrinkles noted after peeling.

*Statistical Analysis*

The statistical analysis was performed using SPSS (version 19.0; SPSS Inc., Chicago, IL), with $P$ value <0.05 considered as statistically significant. The change in visual acuity and CMT were calculated using the differences of preoperative and postoperative data for visual acuity and CMT. The statistical comparison of the changes in visual acuity and CMT were analyzed with paired $t$-test. The difference of clinical parameters between VMT Group 1 and Group 2 was assessed with Mann–Whitney test and Fisher exact test. Multivariate linear regression analysis was performed to assess any predictive factors associated with postoperative visual acuity, visual acuity improvement, final CMT, and postoperative CMT change adjusted by age and sex. The independent variables included OCT pattern, symptom duration, preoperative CMT and visual acuity, age, and sex.

## Results

There were total 22 eyes in 22 patients (15 males, 7 female) who met the inclusion criteria enrolled in this study. The mean age was 73 ± 12 (mean ± SD) years. The mean duration from onset of symptom to surgery was 10 months (range, 1–36), and the mean follow-up period was 25.4 months (range, 6–68). The demographics and ocular parameters of patients before and after operation are shown in Table 1.

The preoperative LogMAR visual acuity was 0.73 ± 0.40 (20/107), and the final LogMAR visual acuity was 0.49 ± 0.42 (20/62) postoperatively. The mean visual acuity improvement was 0.25 LogMAR units (0.3 is approximately two Snellen lines). Most eyes (21/22 eyes, 95.5%) showed visual improvement and 17/22 eyes (77%) had a Snellen visual acuity increase of ≧2 lines. Of 17 eyes with visual acuity improvement ≧2 lines, 11 eyes (65%) were in Group 1; and of 9 eyes had visual acuity increase of ≧3 lines, 6 eyes (67%) were in Group 1. Visual acuity improved one line in 2 eyes, unchanged in 2 eyes, and worsened in one eye.

The CMT of OCT measurement was 563 $\mu$m ± 176 $\mu$m (mean ± SD) before the operation. All 22 eyes had anatomical improvement with a decrease in CMT after operation, and the mean postoperative CMT was 298 $\mu$m ± 69 $\mu$m (mean ± SD) (Table 1).

The difference of BCVA in LogMAR and CMT of patients before and after operation are shown in Table 2. Both the improvement of visual acuity and CMT reduction were statistically significant after operation ($P < 0.01$ respectively). The preoperative and postoperative distribution of BCVA in LogMAR and CMT of all studied patients are also shown in Figure 2.

The demographics and ocular parameters of patients between two groups of VMT classification according

Table 1. Demographics and Ocular Parameters in Eyes With Vitreomacular Traction Syndrome Before and After Vitrectomy Surgery

| Variable | N | Mean ± SD |
|---|---|---|
| Sex | | |
| Male (N) | 15 | |
| Female (N) | 7 | |
| Age, year | | 73 ± 12 |
| Symptom duration, month | | 10 ± 10 |
| Follow-up period, month | | 25 ± 18 |
| Pre-OP | | |
| BCVA (LogMAR) | | 20/107 (0.73 ± 0.40) |
| CMT, $\mu$m | | 563 ± 176 |
| Post-OP | | |
| BCVA (LogMAR) | | 20/62 (0.49 ± 0.42) |
| CMT, $\mu$m | | 298 ± 69 |

BCVA, best-corrected visual acuity; Post-OP, after operation; Pre-OP, before operation.

Table 2. The Difference of Best-Corrected Visual Acuity (BCVA) and CMT of Eyes With Vitreomacular Traction Syndrome Before and After Vitrectomy Operation (N = 22)

| | Mean ± SD | | |
|---|---|---|---|
| | Before Operation | After Operation | *P* |
| BCVA (LogMAR) | 20/107 (0.73 ± 0.40) | 20/62 (0.49 ± 0.42) | <0.01 |
| CMT, $\mu$m | 562 ± 176 | 298 ± 69 | <0.01 |

BCVA, best-corrected visual acuity.

to OCT examination are shown in Table 3. There were 14 patients subclassified as Group 1, and 8 patients as Group 2. Between the two VMT groups, there was no significant difference in age, sex, symptom duration, and follow-up period. There was poorer BCVA in LogMAR in Group 2 than in Group 1 ($P = 0.02$) before operation, but no significant difference in CMT ($P = 0.10$). After operation, BCVA in Group 2 was poorer than in Group 1 ($P = 0.02$). The improvement of BCVA was significantly better in Group 1 than in Group 2 (2.7 Snellen lines vs. 0.8 lines) ($P = 0.03$). However, the decrease of CMT was greater in Group 2 than in Group 1 ($P = 0.04$). Regarding the VMT type, Group 1 was associated with better postoperative BCVA in LogMAR, greater improvement of BCVA; but Group 2 had more decrease of CMT.

Macular anatomical outcome was evaluated by slit-lamp biomicroscopy and OCT examination during each return visit after operation. The preoperative intraretinal cystoid macular change resolved in 20 eyes (91%) and persistent cystoid macular edema in 2 eyes after surgery. The physiologic foveal depression was completely restored in 12 eyes (55%). Abnormal foveal contour was noted in some patients, including lamellar macular hole in five eyes (23%) and diffuse macular thinning with macula atrophy in four eyes (18%). Among 8 eyes of Group 2 VMT, the foveal depression was restored completely in only 2 eyes (25%). Most eyes had some residual macular changes in Group 2 VMT, including macular thinning and atrophy in 3 eyes, lamellar macular hole in 1 eye, persistent cystoid macular edema in 1 eye, and 1 eye with persistent subfoveal fluid. The longitudinal OCT morphological changes of VMT after vitrectomy was demonstrated in one case during a 4-year long-term follow-up (Figure 3).

When all patients were divided into two groups that did or did not have the peeling of ILM during vitrectomy, the postoperative LogMAR visual acuity was 0.51 ± 0.41 (20/65) in ILM-removed group (N = 14) and 0.44 ± 0.46 (20/55) in ILM-not removed group (N = 14), respectively. There was no significant difference of visual outcome between the two groups ($P > 0.05$).

The potential predictive factors of visual outcome and final CMT were analyzed using multivariate linear regression analysis. Table 4 shows that postoperative final visual acuity was significantly associated with OCT pattern of VMT and with symptom duration. Patients with longer symptom duration had worse final visual acuity {$P < 0.01$, regression coefficient $\beta = 0.02$ (95% confidence interval [CI]: 0.01–0.04)}. Final visual acuity decreased by 0.2 Snellen lines per 1-month increase of symptom duration. Furthermore, eyes in Group 1 VMT had better final visual acuity as compared with eyes in Group 2 ($P < 0.01$, $\beta = 0.49$ [95% CI: 0.13–0.86]).

Improvement of visual acuity was significantly associated with age of patients and with VMT pattern. Eyes in Group 1 VMT had more visual acuity improvement as compared with eyes in Group 2 ($P < 0.01$, $\beta = 0.27$ [95% CI: 0.11–0.44]). Moreover, patients of younger age had more visual acuity improvement as compared with patients of older age ($P = 0.02$, $\beta = 0.008$ [95% CI: 0.001–0.014]). Visual acuity improvement decreased by 0.08 Snellen lines per 1 year increase of life.

Postoperative final CMT was significantly associated with symptom duration. Eyes with longer symptom duration had thinner final CMT ($P = 0.02$, $\beta = -4.75$ [95% CI: −8.50 to −0.99]). Improvement of CMT was significantly associated with the OCT pattern of VMT. Eyes in Group 2 VMT had greater CMT decrease as compared with eyes in Group 1 ($P = 0.05$, $\beta = 191.14$ [95% CI: 2.32–379.37]).

Final visual outcome less than 20/100 was observed in 6 cases, and 4 cases were less than 20/200. Of 6 eyes with final visual acuity ≤20/100, there was only 1 case in Group 1, who developed macula atrophy. Conversely, the other 5 cases were in Group 2, including 3 eyes with macula atrophy, 1 eye with persistent cystoid macular edema, and 1 eye with persistent subretinal fluid at fovea.

## Discussion

This study demonstrates that surgical intervention may achieve significant improvement in anatomical and functional outcomes of VMT in this long-term study. In this study, statistically significant vision

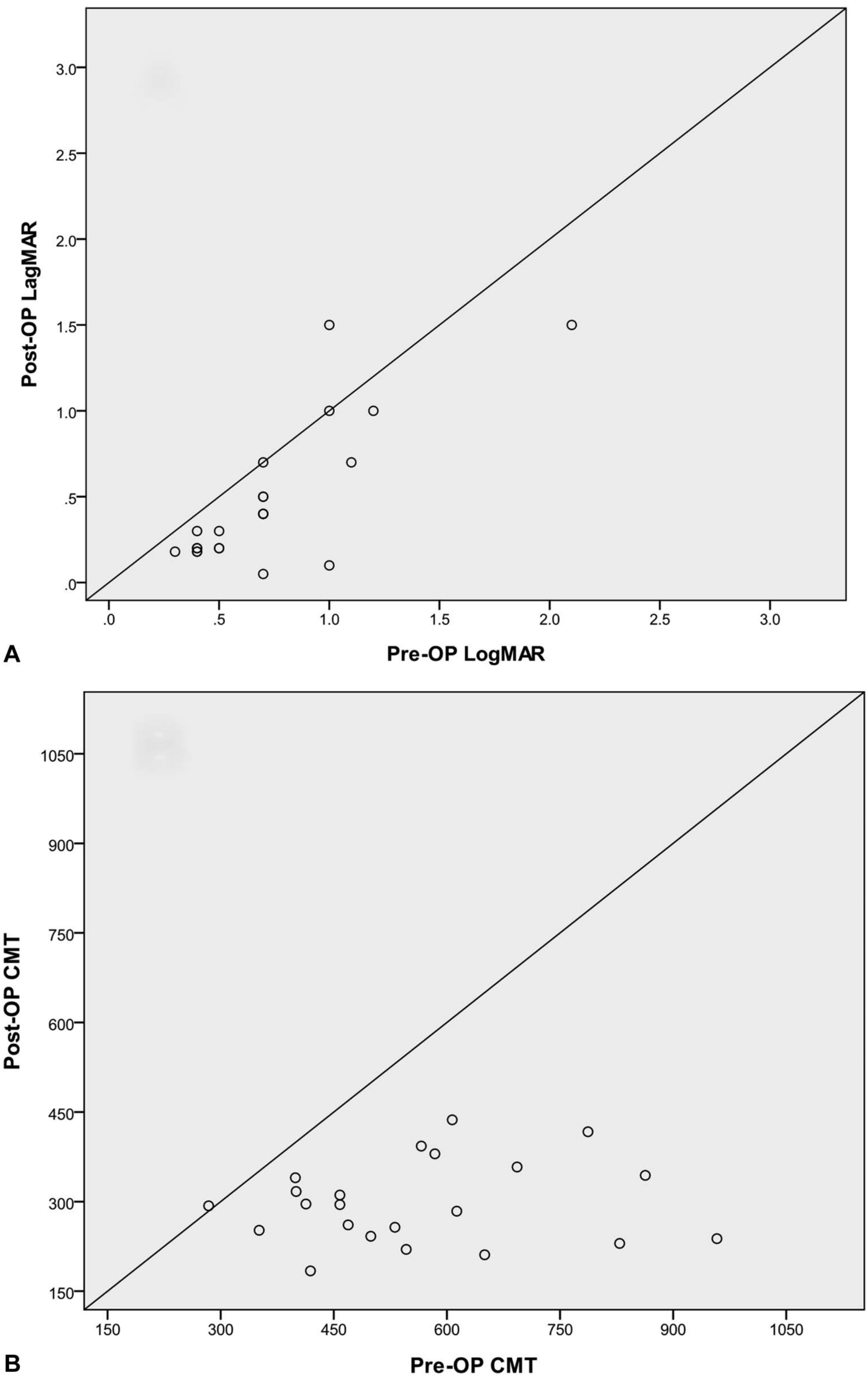


**Fig. 2.** **A.** The preoperative and postoperative distribution of best-corrected visual acuity in LogMAR and (**B**) the Preoperative and postoperative distribution of CMT.

improvement was achieved after vitrectomy surgery and so was the significant anatomical decrease of CMT (264 $\mu$m) in OCT examination postoperatively. Eyes of VMT were further classified according to the vitreomacular attachment diameter based on OCT findings. Multivariate statistical analysis was used to

Table 3. Difference of Demographics and Ocular Parameters Between Two Groups of Eyes With Vitreomacular Traction Syndrome

| | Group 1 (N = 14) | | Group 2 (N = 8) | | |
|---|---|---|---|---|---|
| Variable | N | Mean ± SD | N | Mean ± SD | *P* |
| Sex | | | | | 0.68 |
| Male (N) | 10 | | 5 | | |
| Female (N) | 4 | | 3 | | |
| Age, year | | 76 ± 12 | | 69 ± 9 | 0.18 |
| Symptom duration, month | | 10 ± 10 | | 9 ± 11 | 0.97 |
| Follow-up period, month | | 26 ± 18 | | 25 ± 17 | 0.95 |
| Pre-OP | | | | | |
| BCVA (LogMAR) | | 20/78 (0.59 ± 0.22) | | 20/195 (0.99 ± 0.52) | 0.02 |
| CMT, $\mu$m | | 515 ± 146 | | 645 ± 203 | 0.10 |
| Post-OP | | | | | |
| BCVA (LogMAR) | | 20/44 (0.34 ± 0.36) | | 20/112 (0.75 ± 0.41) | 0.02 |
| CMT, $\mu$m | | 310 ± 63 | | 278 ± 79 | 0.30 |

Group 1: vitreomacular adhesion less than 1,500 $\mu$m in width on OCT.
Group 2: vitreomacular adhesion more than 1,500 $\mu$m in width on OCT.
BCVA, best-corrected visual acuity; Post-OP, after operation; Pre-OP, before operation.

identify the contributing factors to predict the visual outcome after vitrectomy. We demonstrated that OCT pattern, symptom duration, and age of patient are important predictive factors of visual outcome.

Less than one-third of patients developed spontaneous resolution of VMT with complete PVD,[5,7] some symptomatic eyes with persistent vitreomacular traction may undergo a further decrease in visual acuity during long-term follow-up.[6] Those patients who did not have complete vitreomacular separation had less chance of resolved cystoid changes of the macula, and usually had further decrease in visual acuity. The natural course of VMT had been described by Hikichi et al,[4] in which 81% had cystoid macular edema, of which 67% had persisted change during a 60-month follow-up period. The final visual acuities decreased by 2 Snellen lines or more from baseline in 34% of patients with VMT, only 11% developed complete PVD.[4] However, in a large series of natural history study, Tzu et al[7] recently reported that 32% of patients had spontaneous release of VMT, 12% of patients had anatomic progression, and vitrectomy was performed in only 4.1% of patients for worsening VMT or macular hole formation. These observations demonstrate that vitrectomy treatment has benefits to surgically detach the vitreous and relieve the traction from the macula for some patients with nonresolving symptomatic VMT.[22,23]

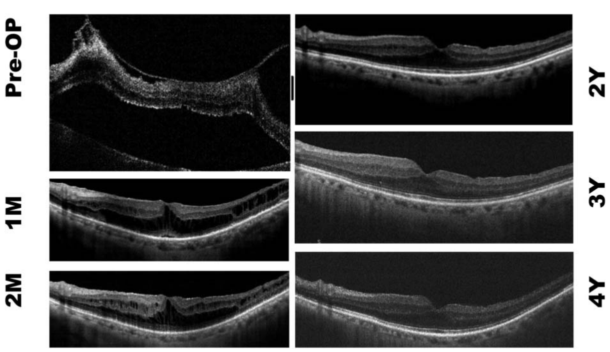


**Fig. 3.** Spectral domain OCT of a 77-year-old patient with VMT: Preoperative OCT showed distortion of retinal surface with tractional macular schisis at baseline and the serial retinal outcome during follow-up after operation. The intraretinal cystoid edema, retinoschisis and retinal folds gradually resolved and the foveal contour subsequently reappeared. Pre-OP, before operation; 1M, 2M, 2Y, 3Y, 4Y; M, month after operation; Y, year after operation.

In our study, most eyes (21/22 eyes, 95.5%) showed visual improvement after vitrectomy, where 17/22 (77%) eyes had an increase of Snellen visual acuity ≧2 lines, and 9 eyes had improvement of ≧3 lines in more than a 2-year follow-up period. There was no significant difference of visual outcome between patients with or without ILM peeling procedure. This result indicates the pathogenesis of VMT is due to anterior-posterior vitreous traction but not tangential traction. Previous studies also showed similar visual acuity improvement after surgery, for example, Smiddy et al[16] reported that 63% of patients (10 in 16) had an increase of visual acuity more than 2 lines. Yamada et al[18] also had a similar reporting of approximately 63%, 9 in 14 eyes with at least 2 lines of visual acuity improvement. However, few patients of VMT still suffered from poor visual outcome after vitrectomy management.[18,23] There were three cases with lesser than one line of improvement in present study. One case with worsened visual outcome ended up with macula atrophy after an 18-month follow-up. The other 2 cases had unchanged visual outcome, 1 case complicated with macula atrophy, and the other had persistent cystoid macular edema 22 months after operation. Therefore, the variation of visual outcome of VMT after

Table 4. Multivariate Linear Regression Analysis Was Performed to Assess the Possible Predictive Factors Associated With Postoperative Final VA, VA Improvement, Final CMT, and Postoperative CMT Change (N = 22)

| Variable | Regression Coefficient β (95% CI) | | | |
|---|---|---|---|---|
| | Final VA | VA Change | Final CMT | CMT Change |
| OCT pattern (Group 1 or Group 2) | 0.492 (0.129 to 0.855)* | 0.274 (0.109 to 0.439)* | −52.0 (−127.9 to 23.8) | 191.14 (2.32 to 380.0)** |
| Symptom duration, month | 0.024 (0.008 to 0.040)* | 0.006 (−0.001 to 0.014) | −4.75 (−8.5 to −0.99)** | 8.5 (−0.8 to 17.9) |
| Pre-op CMT, $\mu$m | 0.000 (0.000 to 0.001) | 0.000 (−0.001 to 0.000) | NA | NA |
| Pre-op VA (LogMAR) | NA | NA | 82.0 (−26.6 to 190.8) | −21.8 (−292.3 to 248.7) |
| Age, year | −0.005 (−0.014 to 0.003) | 0.008 (0.001 to 0.014)** | 2.1 (−0.5 to 4.8) | 1.2 (−5.3 to 7.8) |
| Sex | 0.024 (−0.176 to 0.225) | 0.022 (−0.132 to 0.176) | 10.8 (−56.5 to 78.0) | −106.3 (−273.6 to 61.1) |

*$P < 0.01$.
**$P < 0.05$.
CMT change, postoperative CMT minus preoperative CMT; NA, not available; Pre-op CMT, preoperative CMT; Pre-op VA, preoperative visual acuity; VA change, postoperative VA minus preoperative VA.

vitrectomy indicates that there may be other influencing factors present in different VMT subgroups.

In this study, the improvement of visual acuity was statistically significantly better in Group 1 than in Group 2 (2.7 lines vs. 0.8 lines). Moreover, Group 1 VMT was a good predictive factor of postoperative visual acuity improvement and final visual acuity outcome in the multivariate linear regression analysis. The VMT was initially classified as V-shaped and J-shaped by the characteristic morphology in OCT examination.[18] A varied spectrum of vitreoretinal anatomical configuration in VMT has also been reported.[19] We adopted another classification, in which VMT was subclassified as Group 1 (focal vitreomacular adhesion <1,500 $\mu$m) or Group 2 (broad attachment >1,500 $\mu$m) types.[21] Different types of VMT (either different morphology or diameter of vitreomacular adhesion) may exert different degrees of damage to the macula in the process of PVD. We hypothesize that eyes in Group 2 VMT, with greater involved macula area being affected by vitreous traction, may suffer from greater damage to the retina itself, and less favorable recovery after retina reattachment, compared with eyes in Group 1 VMT.

In this study, the decrease of CMT was less in Group 1 than in Group 2. We found that the amount of decrease of CMT was not compatible with visual acuity improvement of VMT. Multivariate linear regression analysis also showed no significant correlation between preoperative CMT and final visual acuity change in this study. Sonmez et al[19] also reported that patients with focal type of VMT had significantly better visual acuity improvement than in broad type but no difference in CMT change between the two groups. In this study, because there was a trend toward greater CMT in Group 2 than in Group 1 before surgery, it seemed to have more potential for CMT to decrease to normal range after operation. Moreover, we observed some cases of poor visual outcome ending up with macula atrophy, mainly in Group 2. The eyes of macula atrophy usually associated with retinal thinning change.

Moreover, we found that the duration of symptom is another influencing factor of visual outcome. In present study, besides VMT type, symptom duration was also the predicting factor of postoperative final visual acuity. In linear regression analysis, the increase of 1 month of symptom duration predicts a decrease of 0.2 lines of Snellen visual acuity. In the literature, longer duration of symptom was also reported to have less improvement of visual acuity.[19] We hypothesize that prolonged traction damage by longer symptom duration may lead to retinal atrophy and irreversible retinal dysfunction even after relief of vitreous traction. Moreover, longer symptom duration also predicted thinner postoperative CMT in linear regression analysis of the this study. For each 1-month increase of symptom duration, postoperative CMT will be 4.75 $\mu$m less. In this study, macula atrophy with thinner CMT was observed in some patients with longer symptom duration, mostly in Group 2. We hypothesize that chronic vitreous traction may lead to the late outcome of prominent CME or macular atrophy, because retinal structure was irreversibly damaged. Therefore, regarding the prognostic information and surgical timing in patients' consultation, we recommend that earlier surgical intervention seems to have better visual outcome for VMT.

Furthermore, we demonstrated that the age of patients was also a predictive factor of improvement of visual acuity. In linear regression analysis, an increase of 1 year of life predicts a decrease of visual acuity improvement by 0.08 Snellen lines. We hypothesize that the migration of photoreceptor cells and remodeling of retinal wound after vitrectomy may be slower in older patients during the healing recovery stage.

Some potential limitations of our study include its nonrandomized, retrospective study design, and all surgical procedures were completed by two surgeons. Internal limiting membrane peeling was not performed in each of our cases. Symptom duration was recorded according to the patients' recalling of memory subjectively, and each subject may have different sensitivity to the symptoms of metamorphopsia or decrease in vision. Nevertheless, this study followed a cohort of patients with VMT for a long period, and provided valuable information regarding the long-term outcome after surgery up to 2 years. Furthermore, OCT pattern and other preoperative factors have been identified as important predictive factors of visual outcome for VMT.

In conclusion, most patients with VMT gained significant functional and anatomical improvement after vitrectomy in this study. The visual improvement after surgical treatment is significantly associated with the anatomical pattern of VMT and age of patients. Group 1 OCT pattern and shorter symptom duration are important predictive factors of better visual outcome after vitrectomy surgery.

**Key words:** optical coherence tomography, posterior vitreous detachment, vitrectomy, vitreomacular traction syndrome.

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