CORRELATION BETWEEN CENTRAL FOVEAL THICKNESS AND VISUAL ACUITY IN PATIENTS WITH IDIOPATHIC VITREOMACULAR TRACTION

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Purpose: To evaluate the impact of preoperative central foveal thickness (CFT) on visual acuity after surgery in patients with idiopathic vitreomacular traction and to calculate a cut-off value in preoperative CFT.

Methods: Thirty-five patients with idiopathic vitreomacular traction were evaluated retrospectively. A complete ophthalmological examination including spectral domain optical coherence tomography was performed preoperatively and at 12 months after the surgery. Receiver operating characteristic analysis was used to determine the critical point for the CFT associated with improvement of 10 or more letters in visual acuity on the Early Treatment Diabetic Retinopathy Study.

Results: Among 35 patients, the mean CFT at postoperative 12 months was significantly decreased from baseline ($P = 0.001$). Preoperative CFT and visual improvement were not significantly correlated ($r = -0.090$, $P = 0.605$), whereas preoperative CFT and preoperative visual acuity were significantly correlated ($r = 0.757$, $P < 0.001$). Improvement in CFT and visual improvement were also correlated significantly ($r = 0.449$, $P = 0.007$). According to the receiver operating characteristic analysis, the threshold CFT was 471 μm. When 15 patients with CFT thickness under 471 μm were evaluated, preoperative CFT was significantly correlated with improvement in visual acuity after the surgery ($r = 0.561$, $P = 0.030$).

Conclusion: Preoperative CFT is important for the visual prognosis of patients with vitreomacular traction. Preoperative CFT of these patients should be considered in surgical decisions.

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The persistent attachment of the posterior hyaloid to the foveal center with detached vitreous around the macula is known as vitreomacular adhesion.[1] With extra separation of the vitreous, the status may progress to vitreomacular traction (VMT) and the onset of symptoms such as central metamorphopsia and photopsia, or a decrease in visual acuity.[1] Spontaneous release of VMT can occur, and predictive factors of this spontaneous release have been studied. As stated in these studies, adhesion diameters, vitreomacular angle width, treatment of concurrent retinal disease with intravitreal injections, and vitreomacular interface area value are important factors for the spontaneous release of VMT.[2–4] Another important treatment modality in VMT release is ocriplasmin injection.[5] Pars plana vitrectomy (PPV) remains the mainstay of VMT treatment when observation and/or medical therapy are either unsuccessful or not indicated. PPV is a standard treatment procedure for patients with VMT causing symptomatic visual disturbance. Although predictive factors for spontaneous resolution have been determined, how to monitor the patient and when to base surgical decisions on objective criteria have not yet been determined. Previous studies have conflicting results about the preoperative central foveal thickness (CFT) effects on the visual prognosis.[6,7] Studies using optical coherence tomography (OCT) have shown a moderate but significant negative correlation between macular or foveal thickness and visual

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acuity in patients with macular edema associated with diabetes, uveitis, or retinal vein occlusion.[8–10] In this study, we investigate the relationship between CFT and visual improvement after vitrectomy in a specific group of patients.

Optical coherence tomography, which has provided critical insights into various retinal conditions, has proved useful for noninvasive diagnosis and monitoring of macular diseases including VMT.[11]

The aim of our study is to investigate the effect of preoperative CFT on visual alterations in patients with idiopathic VMT and to determine a cut-off value in CFT for the surgery's success.

Materials and Methods

We retrospectively reviewed the medical records of 65 consecutive patients with symptomatic VMT who underwent vitrectomy at Ulucanlar Eye Research and Training Hospital from June 2013 to November 2015, and who were followed up for a minimum of 12 months. Vitreomacular traction was defined according to the International Vitreomacular Traction Study Group Classification.[12] Inclusion criteria were pure V-shaped VMT (no epiretinal or traction membranes) and high-quality, artifact-free spectral domain optical coherence tomography B-scans. We selected only pseudophakic patients. Cases with any other retinal disease that could affect visual potential were excluded, such as diabetic retinopathy, retinal vein occlusion, and macular telangiectasia. History of intravitreal injection, aphakia, postoperative follow-up for less than 12 months, ocular surgery on the study eye in the prior 3 months, and history of ocular trauma in the study eye were also excluded.

All patients were evaluated with a full ophthalmologic examination including biomicroscopic and dilated fundus examination. The best-corrected visual acuity (BCVA) and spectral domain optical coherence tomography were assessed preoperatively and at 12 months postoperatively. A spectral domain optical coherence tomography volume scan (20 × 20 with 49 horizontal sections, ART 15) including en face images and macular mapping image obtained with HRA2 (Heidelberg Retina Angiograph-Optical Coherence Tomography; Heidelberg Engineering, Heidelberg, Germany) of the macula was performed for each study eye. Retinal thickness in the Early Treatment Diabetic Retinopathy Study subfields was analyzed by the retinal thickness map analysis protocol. Visual acuity was measured using the Snellen chart. For statistical analysis, Snellen values were converted to the logarithm of minimum angle of resolution (logMAR) chart. We assessed the associations of 12-month postoperative BCVA changes with preoperative parameters, including BCVA and CFT.

The indications for vitrectomy were decreased visual acuity and metamorphopsia persisting for more than three months. All patients underwent a standard 3-port 25-gauge pars plana vitrectomy. All surgeries were performed by one surgeon under local anesthesia (M.C.). The Constellation Vision System (Alcon Laboratories, Fort Worth, TX) 25-gauge system was used in all cases. All eyes underwent core vitrectomy. After core vitrectomy, triamcinolone acetonide (Sinakort–A 40 mg/mL; I.E. Ulagay, Istanbul, Turkey) was injected into the vitreous cavity. The edge of the hyaloid cortex break was held by the gentle aspiration of the vitrectomy probe. The separation of the posterior hyaloid from the retina started from this edge by gentle cutting and mild aspiration. Removal of posterior hyaloid and complete removal of vitreous was carried out. Internal limiting membrane peeling was not performed, because of unclear additional benefit in addition to removal of the VMT. Intraocular tamponades were not used at the end of surgery.

Statistical analysis was performed using the Statistical Package for Social Sciences version 20.0 for Windows (SPSS Inc, Chicago, IL). All values were reported as mean ± SD. The normality of the data distribution was evaluated using the Shapiro–Wilk test. As the data were not normally distributed, the effect of the PPV was evaluated using the Wilcoxon test. The correlations between the variables were evaluated using Spearman's Rho test. Receiver operating characteristic analysis was used to determine the critical point for the CFT associated with improvement of 10 or more letters in visual acuity on the Early Treatment Diabetic Retinopathy Study . We evaluated the correlation between preoperative CFT of patients below the cut-off value and vision acquisition. The significance threshold was set at $P < 0.05$.

Results

Sixty-five eyes underwent vitrectomy for VMT during the study period and were followed up for at least 12 months postoperatively. However, 10 of these eyes had other retinal diseases besides VMT (i.e., diabetic retinopathy [n = 3], retinal vein occlusion [n = 2], epiretinal membrane [n = 5]). In addition, patients without v-shaped morphology (n = 9) and phakic eye (n = 11) were excluded from the study. Therefore, 35 eyes of 35 patients (20 men [57%] and 15 women [43%]; mean age at vitrectomy 66.2 ± 11.8 years) were included in this study. Table 1 summarizes the patients' characteristics.

Table 1. Patients Demographics and Preoperative Values

No. of eyes	35
Sex (female/male)	15/20
Mean age ± SD, years	66.2 ± 11.8
Range	53–80
Mean preoperative BCVA ± SD (LogMAR) (Snellen)	0.89 ± 0.2 (20/150)
Range	0.4–1.50
Mean preoperative CFT ± SD, μm	585 ± 241
Range	234–1172

No intraoperative and postoperative complications were found in the medical records of the patients included in the study. None of the 35 patients had the internal limiting membrane peeling procedure, and no tamponade was used.

The mean logMAR BCVA was 0.89 ± 0.27 (Snellen equivalent 20/150) at baseline and 0.60 ± 0.57 (Snellen equivalent 20/80) at 12 months after the surgery. The mean BCVA at 12 months after the surgery was significantly improved from the baseline value (P = 0.017). The mean CFT (micrometer) was 585 ± 241 at baseline and 400 ± 189 at 12 months after the surgery. The mean CFT at 12 months after the surgery was significantly decreased from baseline (P = 0.001). No significant correlation was found between preoperative BCVA and postoperative BCVA (r = 0.139, P = 0.424) or between preoperative CFT and visual improvement (r = −0.090, P = 0.605). However, preoperative CFT and preoperative BCVA were significantly correlated (r = 0.757, $P < 0.001$ [Figure 1]). Improvement in CFT and visual gaining were also correlated significantly (r = 0.449, P = 0.007) (Figure 2). Table 2 summarizes the threshold CFT creating 10 or more letters on the Early Treatment Diabetic Retinopathy Study of improvement in visual acuity creating the receiver operating characteristic analysis values. According to the receiver operating characteristic analysis, the threshold CFT was 471 μm. In addition, when 15 patients with CFT thickness under 471 μm were evaluated, preoperative CFT was significantly correlated with gain in visual acuity after the surgery (r = 0.561, P = 0.030) (Figure 3). Preoperative spectral domain optical coherence tomography image of a patient was showed in Figure 4.

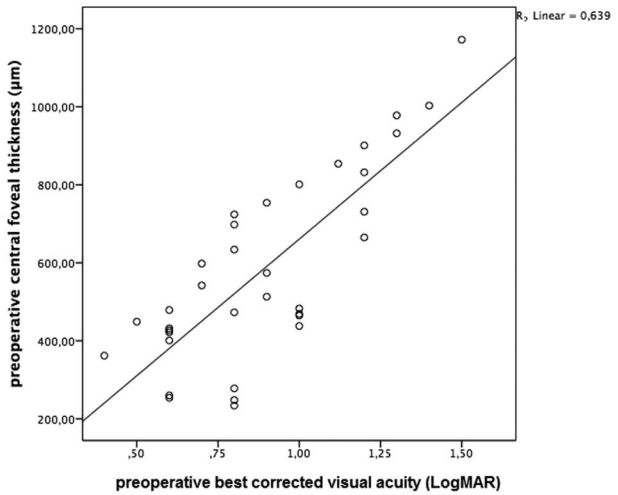

Fig. 1. Correlation between the preoperative central foveal thickness and preoperative best-corrected visual acuity.

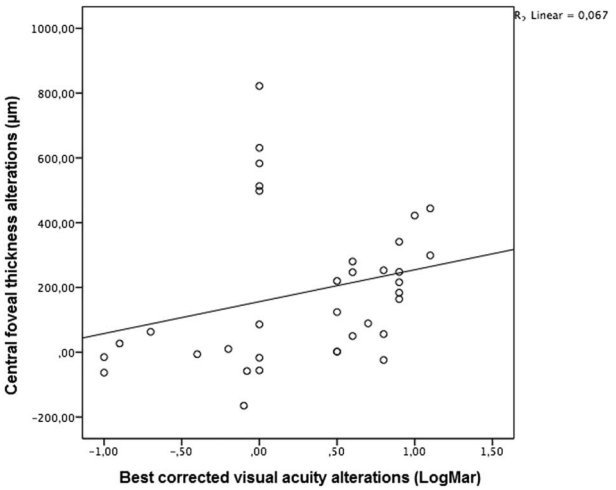

Fig. 2. Correlation between the improvement in central foveal thickness and gaining in best-corrected visual acuity.

Discussion

This study aimed to investigate the effect of CFT on the success of the surgery and to find a cut-off value in patients who received PPV because of VMT. The predictive factors for VMT success have been shown in a number of previous studies.[2–4] To our knowledge; however, this study is the first to investigate a cut-off value for CFT regarding surgical success in VMT.

VMT causes anatomical and functional alterations in the macula because of antero-posterior traction. Slight tractions may be asymptomatic since retinal morphology would be mostly unaffected. Conversely,

Table 2. Receiver Operating Characteristic Analysis of the Central Foveal Thickness

Central Foveal Thickness	
Cut-off point, μm	471
Area under the curve	0.753
95% Confidence Interval	0.594–0.913
Sensitivity, %	81
Specifity, %	58
P value	0.011

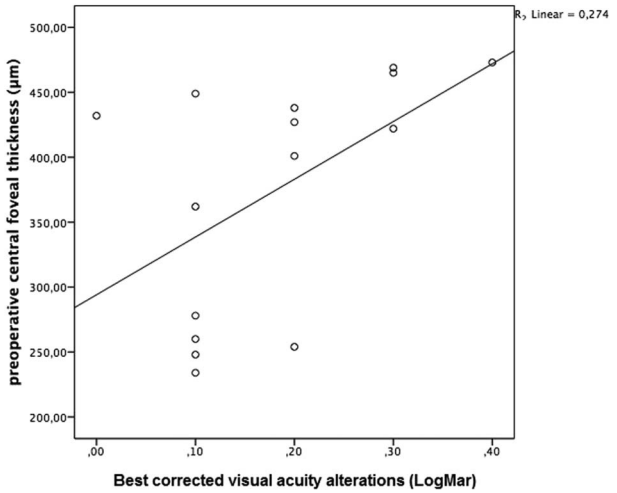

Fig. 3. Correlation between the preoperative central foveal thickness and postoperative best-corrected visual acuity.

severe cases develop reduced visual acuity, metamorphopsia, aniseikonia, and central scotoma because of cystoid macular edema and distortion in outer retinal layers.[1,13] Spontaneous resolution may be seen in 26% to 43% of the patients within the natural course of VMT.[2,3,14,15] However, for progressive VMTs, which impair visual quality, treatment options should be considered. Especially in recent years, intravitreal applications of ocriplasmin and C3F8 have been successful. In a MIVI-TRUST study, a single dose application of ocriplasmin, compared with saline injections, achieved 18% more VMT resolution.[5] Compared with PPV, ocriplasmin is a relatively easier procedure but it may have side effects such as vitreous floaters, photopsia, conjunctival hemorrhage, blurred vision, visual impairment, acute vision loss, dyscromatopsia, nyctalopia, ERG changes, subretinal fluid, and outer retinal OCT signal abnormalities.[16] In addition, in the study by Chang and Smiddy,[17] PPV was found to be more cost effective than ocriplasmin and saline. Although Steinle et al[18] achieved 83% success with C3F8 in patients with VMT, their study was conducted among a small and relatively heterogenic patient population. Despite the developments of less invasive treatments, PPV still protects its importance in the treatment of VMT.

Previous studies have shown that macular thickness has a negative correlation with visual acuity, especially in diabetic patients.[8,19] Moreover, visual gain after various treatments in diabetic patients has also been found to correlate with a reduction in macular thickness.[20,21] In this respect, it can be proposed that preoperative CFT may predict postoperative visual gain in patients with VMT. Sonmez et al[6] reported that preoperative CFT is a predictive factor for postoperative visual acuity. They also found that the thickness of CFT is correlated with the increase in postoperative BCVA. Although Ichiyama et al[7] failed to find a significant correlation between CFT and postoperative vision; they found a significant correlation between outer foveal thickness and the length of the photoreceptor outer segment. Both of these studies included patients with epiretinal membrane and cataracts. It has been shown that the repeatability of OCT is worse in the presence of cataracts compared with postcataract surgery.[22] Moreover, it may be thought that the presence of epiretinal membrane may affect postoperative BCVA change. Even though our study excluded patients with cataracts or epiretinal membrane, preoperative CFT was not correlated with postoperative visual gain. However, the alteration in CFT was significantly correlated with an increase in visual acuity, which might be because visual acuity does not increase when the CFT exceeds a certain thickness. The receiver operating characteristic analysis indicated that the rate

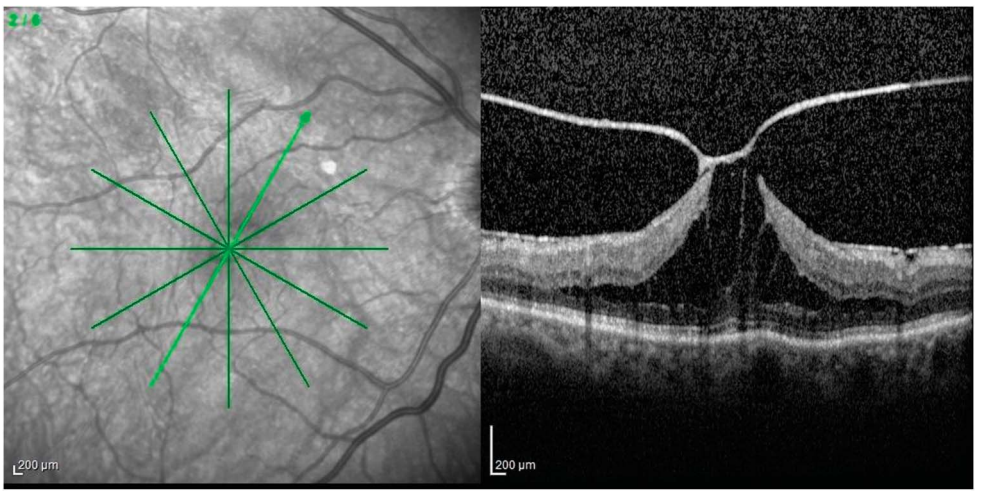

Fig. 4. Preoperative optical coherence tomography image in patient with vitreomacular traction.

of 10 letters gain in visual acuity reduces when the CFT exceeds 471 μm. When we accepted 471 μm as a cut-off value and analyzed the patients with a CFT lower than 471 μm, we observed a significant positive correlation between CFT and visual gain (Figure 3). The conflicting results in the literature could be attributed to variances in CFT levels. Although visual gain is higher in patients with higher preoperative CFT, the success rate reduces after a certain thickness.

Sonmez et al[6] reported a higher anatomical and functional success rate in V-type VMT and at least 280 μm healing in V-shaped VMT. In our study, the average reduction in CFT was 185 μm. Other studies also reported that vitrectomy leads to an average reduction of 100 to 220 μm in CFT.[6,7,23–25] The CFT changes were smaller in these studies because they were performed on heterogenic patient groups.

According to the meta-analysis by Jackson et al,[26] visual acuity improvement is around 0.25 logMAR (Snellen equivalent 20/35) after surgery in patients with idiopathic VMT. It is reported that the peeling of the internal limiting membrane during surgery makes no difference in terms of visual gain.[26] Sonmez et al[6] found at least one logMAR visual gain in 87.5% of the patients, but they did not observe visual acuity reduction in any of their patients. Smiddy et al[27] reported at least 10 letters visual gain in 63% of their patients. Yamada and Kishi[23] also found at least 10 letters visual gain in 63% of their patients. Johnson[24] reported at least 10 letters visual gain in 8 (100%) of 8 operated eyes. In our study, we observed 10 letters visual gain in 54% of the patients; however, visual acuity did not change in 25% of the patients. The high preoperative CFT was noted in our study. The relatively low visual gain may be related with high preoperative CFT.

In many retinal diseases, preoperative BCVA has been shown to be correlated with postoperative BCVA increase.[28–30] However, preoperative BCVA is not correlated with postoperative BCVA in VMT patients.[7] In addition, factors such as dysfunction in the internal retinal layers because of the severity of the available traction and the time passed with the disease may lead to differences in the surgical response of each patient. Our study also found that preoperative BCVA was not correlated with postoperative BCVA.

In conclusion, preoperative CFT is important for the visual prognosis of patients with VMT. Preoperative CFT of these patients should be considered in surgical decisions. We offer that patients with high CFTs should be warned that the prognosis for postoperative visual improvement.

Key words: central foveal thickness, optical coherence tomography, vitreomacular traction.

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