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Original Article

A study on change of macular retinal thickness and its relationship with vision before and after operation to idiopathic macular epiretinal membranes

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Abstract: Objective: To evaluate the change of macular retinal thickness and vision before and after 23G minimally invasive vitrectomy to idiopathic macular epiretinal membranes. Methods: Clinical data of 40 patients who were confirmed as idiopathic epiretinal membrane and accept vitrectomy combined with internal limiting membrane peeling was retrospectively analyzed. In regular follow-up before and after operation, OCT (optical coherence tomography) inspection was conducted for the best corrected visual acuity, intraocular pressure, eye-ground photography, and fundus oculi. In addition, the follow eye which has no relevant ophthalmological disease was treated as the control group. Results: The vision greatly improves after operation, and the thickness in central fovea of macula significantly decreases. Postoperative vision shows obvious linear correlation with postoperative thickness in central fovea of macula. The thickness in division 9 of macula sharply decreases after operation, while the retina in central macula and nasal sides significantly thickens compared with normal group. Conclusion: Internal limiting membrane peeling can enhance the vision of patients and improve macula morphology, while the status in central macula and nasal side has not completely recovered.

Keywords: Idiopathic macular epiretinal membranes, minimally invasive vitrectomy, internal limiting membrane peeling, best corrected visual acuity, macular retinal thickness

Introduction

With unclear pathogenesis, idiopathic macular epiretinal membranes mainly occurs to patients beyond 50 ages. The morbidity in 50 ages is 2%, while in 75 ages is 20% [1-3]. Epiretinal membrane may result in the vision decay, metamorphopsia, macular oedema, macula transformation, macular retinal ruffle, vessel transformation and distortion, and even retinal tear for traction. Vitrectomy can effectively strip the epiretinal membrane. By peeling the internal limiting membrane with ICGA staining, the retinal ruffle can be effectively recovered, the anatomical structure of macular region can be better recovered, and recurrence can be reduced [4-6]. For patients with idiopathic macular epiretinal membranes, the change of retinal thickness in 9 subarea of macular compared with normal eye is rarely studied, so is the change of retinal thickness in 9 subarea of macular after minimally invasive vitrectomy combined with internal limiting membrane peeling. This study: 1. applies spectral-domain optical coherence tomography (SD-OCT) to observe the morphological features of macular retina of patients with idiopathic macular epiretinal membranes (IMEM) before operation, and compare the difference between the retinal thickness in macular area and that of normal control eye to analyze the relationship between the retinal thickness in macular central fovea and best corrected visual acuity; 2. observes the change of vision and macular retinal thickness of patients with idiopathic macular epiretinal membranes after 23G minimally invasive vitrectomy for peeling macular epiretinal membrane combined with internal limiting membrane peeling, and the recovery change of macular retinal thickness. In addition, this study further dis-

cusses the linear correlation between the change of macular thickness and vision change, evaluates the therapeutic effects on idiopathic macular epiretinal membranes, and discusses the clinical application value of OCT in idiopathic macular epiretinal membranes.

Object and methods

Object

40 eyes of 40 patients who were confirmed as idiopathic epiretinal membrane, and accept operative treatment and complete follow-up from April 2011 to October 2013 are retrospectively analyzed to exclude patients with the second epiretinal membrane, secondary epiretinal membrane (because of operation, trauma, laser operation, etc.), glaucoma, diabetic retinopathy, macular degeneration related to age, and retinal vein occlusion. All the patients accepted treatment of best corrected visual acuity (BCVA), slit lamp, spectral-domain optical coherence tomography (SD-OCT), and inspection of fundus colorful photography. Moreover, the fellow eyes of these patients were taken as normal control group after eliminating relevant fundus diseases.

Operation methods: 23G minimally invasive vitrectomy, epiretinal membrane peeling, internal limiting membrane peeling, and injection of 2 mg triamcinolone into vitreous cavity were conducted. Applying 23G mini-cannula system, triamcinolone was injected into rear pole for staining after excising the front vitreous body in three channels of 23G minimally invasive vitreous body established by conjunctiva. Residual vitreous body was excised clearly after separating the vitreous body by attraction. After peeling epiretinal membrane with 23G retinal tweezers, indocyanine green was dripped in macular area. The indocyanine green in vitreous cavity was replaced completely after straining the internal limiting membrane to light green for 20 s. After clamping the internal limiting membrane with retinal tweezers, internal limiting membrane was annularly peeled along the central fovea in peeling diameter of about 3-4 PDs. After the surrounding retina was inspected as normal, fluid-air exchange was conducted and 2 mg triamcinolone was injected into vitreous cavity. Then, 23G trocar was pulled out, and puncture mouth was occluded until there is no obvious leakage. If there is obvious leakage, one stitch should be seamed at sclera puncture mouth.

Observational indices in follow-up

All the patients should accept international standard vision inspection and best corrected visual acuity, as well as inspections by slit lamp, ophthalmoscope, fundus color photo, spectral-domain optical coherence tomography, and fluorescence fundus angiography (FFA), etc. The occurrence of complications was observed to record the best corrected visual acuity, intraocular pressure, macular morphology, and retinal thickness in 9 subarea of macular in the first month, third month, and sixth month. In addition, central fovea thickness (CFT) of macular and distance between internal limiting membrane in central fovea and that of blood capillary multiple bed in pigment epithelium choroid membrane were manually measured by cliper in software for three times, and the mean was taken. OCT inspection was conducted to the normal control eye to record the retinal thickness in subarea 9 in macular.

Statistical method

For patients with idiopathic macular epiretinal membranes, the retinal thickness in every area of nine macular divisions was compared between ill eye and healthy eye before and after operation, and best corrected visual acuity and macular central fovea thickness (CFT) measured by OCT were followed up in the first month, third month, and sixth month for data analysis. Obtained data was statistically processed with SPSS software. BCVA and macular central fovea thickness before and after operation, and the retinal thickness in all macular areas were compared by matching T testing. If $P < 0.05$, the difference has statistical significance. For the analysis on linear correlation between BCVA and macular central fovea thickness, Pearson's linear correlation coefficient analysis was used. If $P < 0.05$, there is linear correlation.

Research results

General condition

This subject completed the experimental study on 40 eyes (40 cases), including 18 eyes of male patients accounting for 45% and 21 eyes of female patients accounting for 55% in which 23 eyes were right eyes accounting for 57.5% and 17 eyes were left eyes accounting for

Table 1. Preoperative and postoperative changes of BCVA and CFT ($\bar{x} \pm s$)

	Pre-operation	1 month after operation	3 month after operation	6 month after operation
BCVA	0.15±0.09	0.25±0.18*	0.32±0.22*	0.35±0.20*
CFT (μm)	479.85±107.56	389.67±97.83*	349.78±86.95*	325.38±94.99*

*express VS pre-operation $P < 0.05$.

42.5%. The age of these patients was in range of 52-83 with the average age of (65.68±6.62). All of these patients completed 6-month follow-up observation. During the follow-up, no enophthalmia, increasing intra-ocular pressure, retinal detachment, and recurrence of epiretinal membrane was observed.

Change of vision and macular central fovea thickness

Comparing the improvement situation of visual function before and after operation in 6-month follow-up, the vision of 35 eyes enhanced accounting for 87.5%, while only 5 eyes did not enhance accounting for 12.5%. The best corrected visual acuity increased from 0.15±0.09 before operation to 0.35±0.20 in the sixth month of follow-up, which shows that it increases 0.2, while the vision of 5 patients did not improve. The vision of patients before and after operation significantly improved with statistical significance ($t = 6.926$, $P < 0.05$) shown in **Table 1** During follow-up, no intra-ocular pressure, the recurrence of epiretinal membrane, ehophthalmia, retinal detachment, and other complications was observed.

Comparing the change of macular central fovea thickness before and after operation, the average thickness of macular central fovea before operation is 479.85±107.56 μm, and that 6 months after operation is 325.38±94.99 μm, which decreases 154.47±110.80 μm on average. The difference of macular central fovea thickness before and after operation has statistical significance ($t = 8.818$, $P < 0.05$) shown in **Table 1**. The comparison of preoperative and postoperative OCT images, we can see, idiopathic macular epiretinal membrane in the vitrectomy surgery combined with macular epiretinal membrane peeling in operation and internal limiting membrane peeling surgery, macular epiretinal membrane of retinal surface of a narrow high reflection signal band disappeared. After operation, the macular central fovea thickness of all patients decreased (**Figure 1**). The quickest recovery of vision and reduction of macular central fovea occurred in one month after operation, and the vision is still recovering and the macular central fovea thickness is still decreasing 6 months after follow-up.

Comparison of retinal thickness in all areas with normal fellow eyes before and after operation

Table 2 lists the retinal thickness in 9 macular areas of patients with idiopathic macular epiretinal membranes before operation and that of fellow eyes. It can be seen that the most macular subareas of patients with idiopathic macular epiretinal membranes significantly thicken compared with the retinal thickness of normal eye ($P < 0.05$), only the thickness in bitemporal side has no significant difference compared with the control group.

The most retinal thickness in 9 macular areas of patients with idiopathic macular epiretinal membranes significantly reduced 6 months after operation (the comparison before and after operation shows significant difference, $P < 0.05$). Only the retinal thickness in exterior lower area has no significant difference before and after operation ($P > 0.05$) (**Table 2**).

By comparing the retinal thickness in 9 macular areas with that of normal control group in follow-up 6 months after epiretinal membrane operation, the retinal thickness in macular center and nasal side is significantly thicker than that of control group ($P < 0.05$), while the thickness in macular bitemporal has no significant difference with that in control group ($P > 0.05$) (**Table 2**).

Linear correlation relationship between vision and macular central fovea thickness

According to the analysis of linear correlation between BCVA before operation and macular central fovea thickness before and 6 months after operation, between vision after operation and macular central fovea thickness before and after operation, between improvement sit-

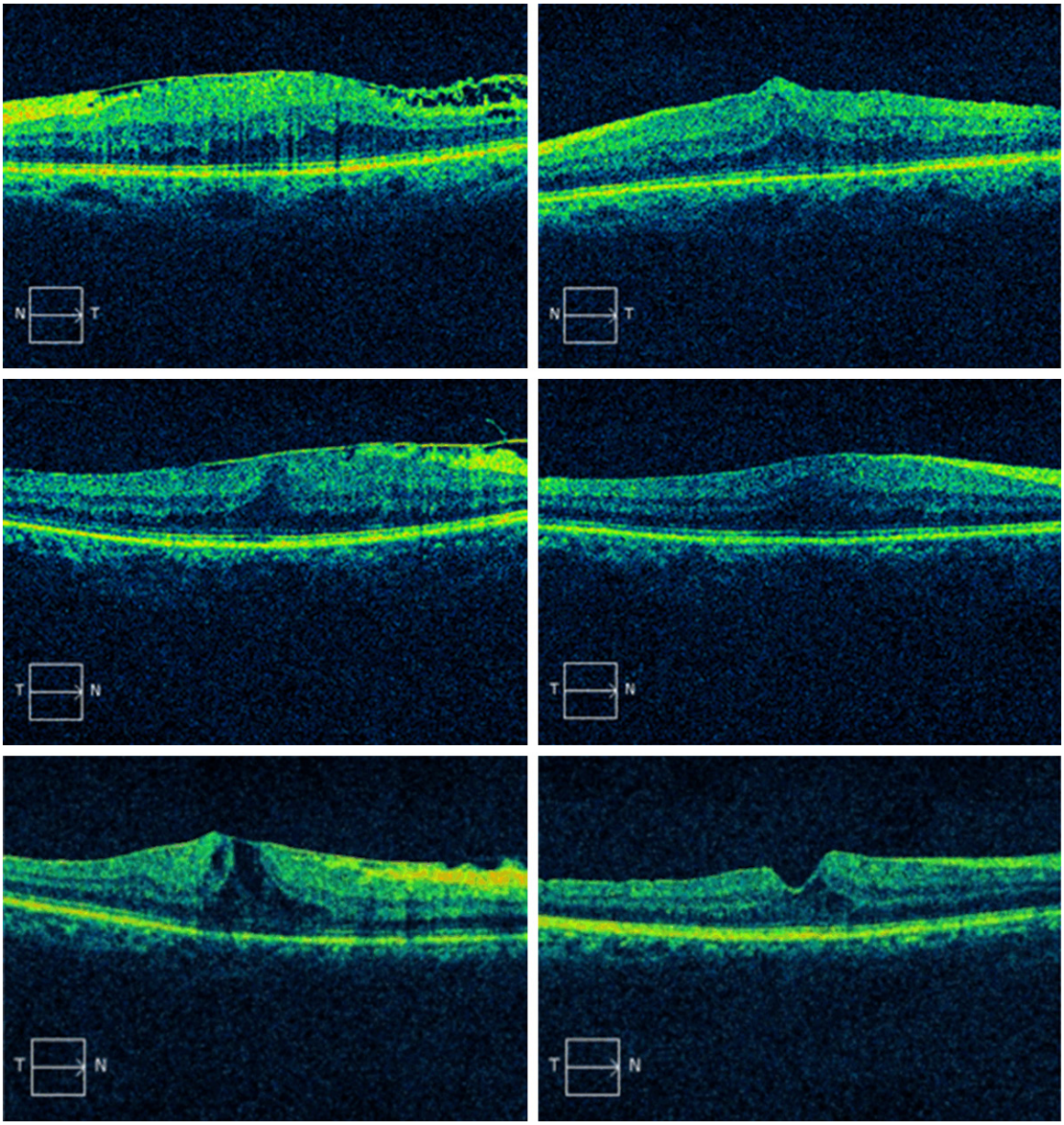


Figure 1. Examples of the change of OCT images before and 6 months after IMEM operation. The preoperative and 6-months' postoperative are shown on the left and right, respectively.

uation of vision and macular central fovea before and 6 months after operation, the results show that BCVA after operation has linear correlation with macular central fovea after operation ($r = 0.346$ and $P = 0.029 < 0.05$ showing significant correlation), but has no linear correlation with others ($P > 0.05$) (**Figure 2**).

Discussion

There is still a dispute that if internal limiting membrane peeling is necessary in operation to idiopathic macular epiretinal membranes [7]. Internal limiting membrane is easily peeled after marking with indocyanine green. After taking internal limiting membrane peeling, the retinal fold can obviously turn flat [8]. The internal limiting membrane peeling in idiopathic macular epiretinal membranes will not endanger the functional recovery after operation [9]. In this study, epiretinal membrane can be peeled by indocyanine green staining after triamcinolone staining in 23G minimally invasive vitrectomy for 40 eyes of 40 patients with idiopathic macu-

Table 2. Imem patients before and after operation 6 months and normal thickness of the retina of the area of the contralateral eye contrast analysis

Retinal thickness	Fellow eyes	Pre-operation	6 months after operation
Central	242.81±23.71	458.10±129.04*	348.10±86.69*,#
Inner superior	306.55±19.42	417.70±92.13*	345.84±58.07#
Inner nasal	310.63±14.82	436.45±90.04*	363.68±68.36*,#
Inner inferior	307.63±13.26	420.10±97.55*	335.52±73.71*,#
Inner temporal	301.63±14.82	424.95±115.05*	333.11±46.89#
Outer superior	274.60±13.25	318.10±50.73*	264.78±105.83#
Outer nasal	290.92±8.34	361.53±77.45*	323.83±47.68*,#
Outer inferior	260.90±12.84	309.20±66.75*	274.87±48.32
Outer temporal	254.90±11.50	323.00+79.85	255.72±83.45#

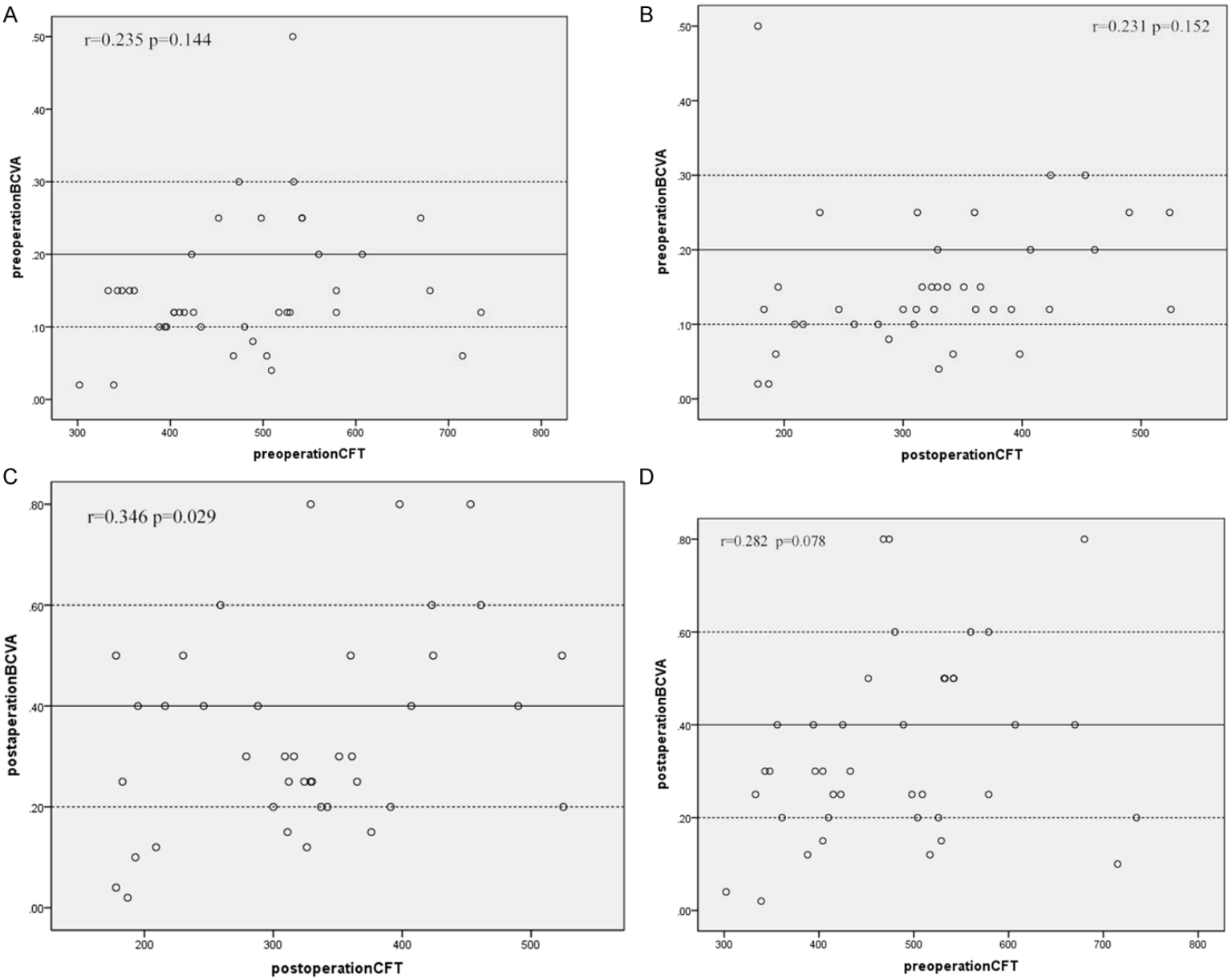
*express vs control, P < 0.05; #express vs before operation P < 0.05.

lar epiretinal membranes. Vitrectomy can well peel the epiretinal membrane to improve the vision of patients. In this study, we compared and analyzed the improvement situation of patient visual function before and after operation. It can be seen that there is no significant difference between BCVA before and after operation. The vision of 35 eyes improved accounting for 87.5%, and only 5 eyes did not improve accounting for 12.50%. The best corrected visual acuity (BCVA) was 0.15±0.09 before operation, BCVA 1 month after operation is 0.25±0.18, and BCVA 3 months after operation is 0.3±0.22, and BCVA 6 months after operation is 0.35±0.20. This shows that the best corrected visual acuity increases 0.2. Vision of the most patients significantly improves after operation, and the difference in different period after operation and before operation has statistical significance. The vision restored fastest in the first month after operation, and the vision still slowly improves in later follow-up period. During follow-up, intraocular pressure does not increase, and no recurrence of epiretinal membrane is observed.

The vision for patients with epiretinal membrane after operation has close relation with the functional form of macular [10, 11]. OCT can well show the change of retinal form when displaying epiretinal membrane. The shrinkage of epiretinal membrane may result in the thickness increase in macular area. This edema continuously exists even after epiretinal membrane peeling [12]. The objective of this experiment is to inspect the change of thickness and morphology of macular central fovea before and after operation by OCT technology. The average thickness of macular central fovea before operation is 479.85± 107.56 μm, while the thickness of macular central fovea 1 month after operation is 389.67± 97.83 μm, that 3 months after operation is 349.78±86.95 μm, and that 6 months after operation is 325.38±94.99 μm. Macular central fovea thickness of all patients decreased, which decreased most significantly in the first month after operation.

It can be found that macular central fovea thickness significantly reduces after epiretinal membrane peeling, while the thickness of most macular central fovea does not recover to normal. Mazit C [13], et al. found that the thickness of macular cannot recover, but has almost no influences on the recovery of other functions.

This study applies the nine division analysis mode in Macular Thickness analysis software brought by Cirrus HD-Model 4000 OCT instrument to do determination and morphological observation of macular thickness before and after operation for idiopathic macular epiretinal membranes. Therefore, we can have comprehensive observation and understanding on the recovery of macular area for patients with idiopathic macular epiretinal membranes before and after operation. With Fourier domain technology and broadband light source technology by three-dimensional spectral domain OCT, the scanning speed will be improved, the axial resolution can be improved to 5 μm, and the structure of macular retina can be displayed more accurately. With 512 × 126 linear scanning mode, it can avoided to omit small and early lesion. In aspect of ophthalmology, OCT provides the best technology of retinal structure imaging up to now [14]. Moreover, the application of relevant software technology can make spectral-domain OCT quantitative analysis tools more accurate and comprehensive. The retinal thickness measured by spectral-domain OCT is the distance between retinal pigment epithelium and internal limiting membrane of retina. The measured retinal thickness is complete, so the actual structure in macular area can be reflected and the interface struc-


A
r=0.235 p=0.144
preoperationBCVA
preoperationCFT
B
r=0.231 p=0.152
preoperationBCVA
postoperationCFT
C
r=0.346 p=0.029
postaperationBCVA
postoperationCFT
D
r=0.282 p=0.078
postaperationBCVA
preoperationCFT

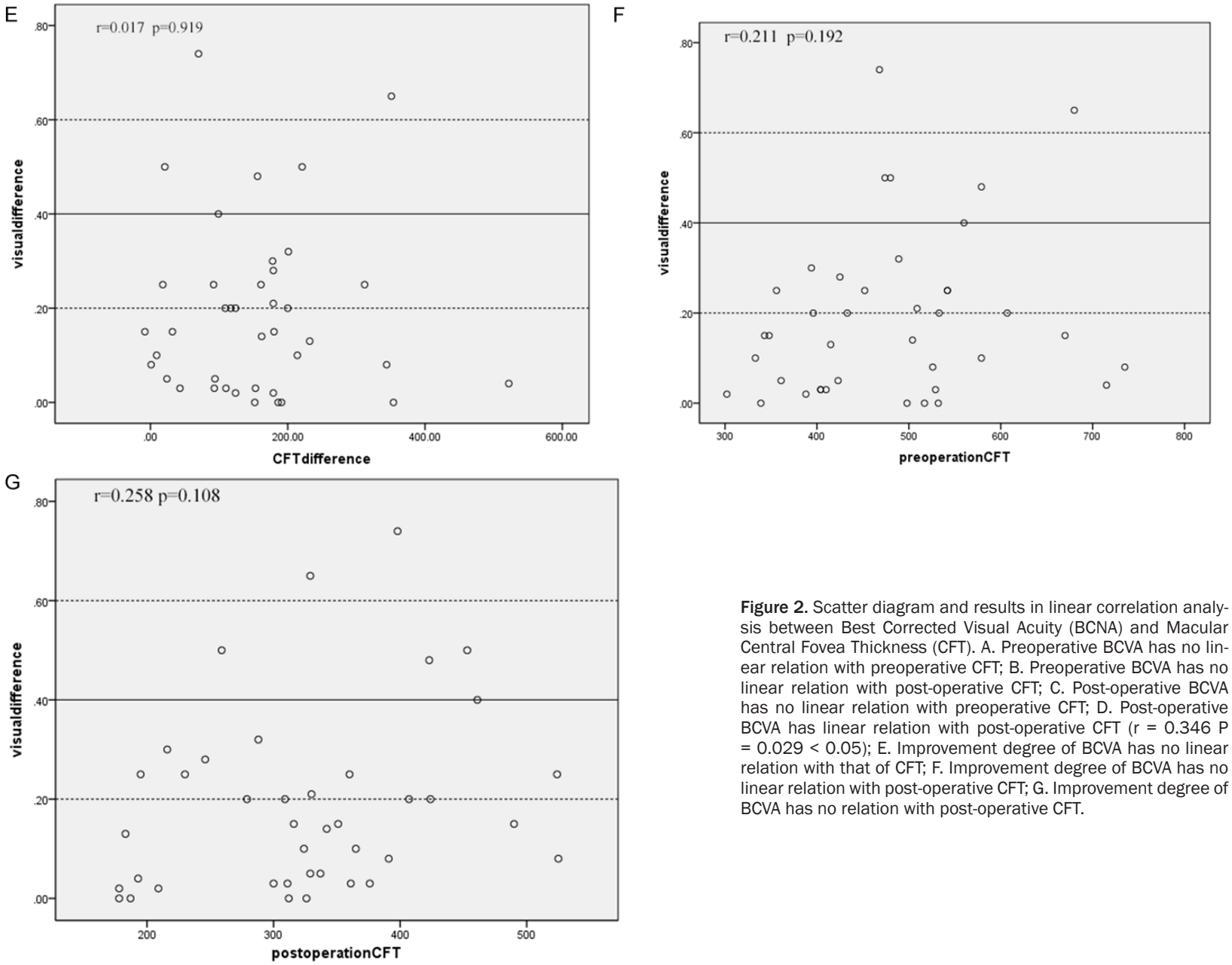


Figure 2. Scatter diagram and results in linear correlation analysis between Best Corrected Visual Acuity (BCNA) and Macular Central Fovea Thickness (CFT). A. Preoperative BCVA has no linear relation with preoperative CFT; B. Preoperative BCVA has no linear relation with post-operative CFT; C. Post-operative BCVA has no linear relation with preoperative CFT; D. Post-operative BCVA has linear relation with post-operative CFT ($r = 0.346$ $P = 0.029 < 0.05$); E. Improvement degree of BCVA has no linear relation with that of CFT; F. Improvement degree of BCVA has no linear relation with post-operative CFT; G. Improvement degree of BCVA has no relation with post-operative CFT.

ture of vitreous body can be displayed more accurately [15].

For patients with idiopathic macular epiretinal membranes, the retinal thickness in 9 macular areas of eyes with idiopathic macular epiretinal membranes and fellow eyes was compared. It can be found that the retinal thickness in the most macular subareas of patients with idiopathic macular epiretinal membranes significantly thickened compared with that of normal eyes ($P < 0.05$), while the thickness at temporal side has no significant difference with control group. It can be found that the thickness in macular central area thickens the most, which is about 225 μm thicker than that in fellow normal eyes, and about 135 μm thicker than that in retinal thickness at internal macular nasal side.

After the operation for idiopathic macular epiretinal membranes, the most retina in 9 macular subareas significantly attenuates, and the retinal thickness in the most 9 macular areas of patients with idiopathic macular epiretinal membranes significantly reduces before and after operation (comparing the thickness before and after operation, there is significant difference, $P < 0.05$). There is no significant difference of the retinal thickness in exterior lower area before and after operation ($P > 0.05$).

During 6-month follow-up after operation for epiretinal membrane, it can be found in the comparison between retinal thickness in 9 macular areas and that in normal control group that in the longest period of follow-up, the retinal thickness of macular in central area and internal nasal side is significantly higher than that of control group ($P < 0.05$), while there is no significant difference between the thickness at macular bitemporal side and upper area and that of control group ($P > 0.05$).

Treunmer [16] et al. reported that the retinal thickness at internal macular nasal side significantly thickens in 46 months of follow-up after conducting internal limiting membrane peeling for idiopathic macular epiretinal membranes, while the retinal thickness in other macular subareas, including the retinal thickness at macular bitemporal side will decrease to normal. Although the follow-up period in this study is short, the fellow eyes are taken as control. The result in this study is consistent with that of Treunmer: retina at nasal side significantly thickens and never reduces to normal in central area and macular near-pit area during follow-up, while retina at internal temporal side and upper area in macular area almost reduces to normal in 6-month follow-up. According to this study, compared with the retinal thickness of follow normal eyes, the retina in macular central area is 106 μm thicker, that at internal nasal side is about 53 μm thicker, that at external nasal side is about 33 μm thicker, and that in macular central fovea nasal side is about 53 μm thicker after operation.

There is still dispute in the importance of macular central fovea thickness on vision. Some data shows that Suh MH, Seo JM, et al. [17] found that vision improvement has linear correlation with the decrease of macular thickness, while Shimozono and Oishi [18] found that BCVA has no significant relation with macular central fovea. Just as this study, when analyzing the linear relationship between best corrected visual acuity before and after operation and the macular central fovea thickness before and after operation, we found that preoperative BCVA has no linear relation with preoperative central fovea thickness, preoperative BCVA has no linear relation with central fovea thickness, preoperative BCVA has no relation with postoperative central fovea thickness, and postoperative BCVA has no relation with preoperative thickness. However, we found that postoperative BCVA has significant linear relation with post-operative macular central fovea.

Chang [19] reported that internal limiting membrane peeling in epiretinal membrane cannot affect vision prognosis, but can reduce the recurrence of epiretinal membrane. In addition, Lee and Kim [20] reported that it is more common that macular thickness and morphology of patients treated with internal limiting membrane peeling cannot recover than patients who were only peeled the epiretinal membrane. They also reported that internal limiting membrane peeling has no damage to final vision function, but may cause multifocal electrophysiological abnormality to damage Müller cells and macular structure.

However, this study still has some deficiencies. First of all, this is a retrospective study which is lack of control group without internal limiting

membrane peeling. Therefore, these two operations cannot be compared. Secondly, no further observation is conducted on retinal function and other aspects, including retinal electrophysiology. Thirdly, it is lack of observation and study on the change of structure in all layers of OCT retinal membrane in macular area before and after operation, as well as the study on relationship with vision recovery. Balducci [21] et al. observed the change in nerve fiber layer of patients with epiretinal membrane after operation, and found that the thickness of nerve fiber layer also decreases. This study is only limited in observing the change of retinal thickness before and after operation to idiopathic macular epiretinal membranes and the change of vision function, but not further discuss the reasons for this change, including the reason of why the retina in macular central area and central nasal side cannot recover to normal after operation.

In conclusion, 23G minimally invasive vitrectomy combined internal limiting membrane peeling and injection of triamcinolone to vitreous body has effective curative effects in the treatment of idiopathic macular epiretinal membranes. It can significantly improve patient vision, reduce macular central fovea thickness, and perfect macular morphology. In the most cases, however, macular thickness cannot completely recover, and the potential damage to visual nerve of internal limiting membrane peeling also requires further study. Moreover, it also requires to further discuss why retinal thickness cannot recover to normal after epiretinal membrane operation and its relevant factors, as well as the way to improve the recovery of retinal thickness.

Disclosure of conflict of interest

None.

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