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Original Article

Vitrectomy results of macular retinal thickness and vision acuity for idiopathic epiretinal membranes

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Abstract: Background: To evaluate the relationship between visual acuity and the changes of macular retinal thickness before and after 23G vitrectomy to the idiopathic epiretinal membranes (ERMs) by using optical coherence tomography (OCT). Methods: In this retrospective study, we examined 82 eyes of 78 patients who were confirmed as having an idiopathic epiretinal membrane and accepted pars plana vitrectomy combined with internal limiting membrane (ILM) and epiretinal membrane peeling. All patients underwent complete ophthalmologic examination, including best corrected visual acuity (BCVA), slit-lamp examination, intraocular pressure, OCT and fundus photography. Patients were followed for six months. The relationship between the BCVA and retinal thickness, via OCT features were evaluated. Results: The BCVA improved from 0.26 ± 0.16 to 0.36 ± 0.16 ($t = 9.843$, $P < 0.0001$), the mean foveomacular retinal thickness decreased from 506.41 ± 112.67 μm to 442.39 ± 82.10 μm ($t = 5.526$, $P < 0.0001$) after vitrectomy for IMEM patients. The parafovea macular retinal thickness decreased from 453.66 ± 79.36 μm to 409.95 ± 61.63 μm ($t = 6.164$, $P < 0.0001$) postoperatively. There was not a statistically significant difference between preoperative perifovea thickness (365.93 ± 50.84 μm) and postoperative perifovea thickness (356.76 ± 54.20 μm) ($P > 0.05$). Post-operation BCVA has an obvious linear correlation with preoperative BCVA, so does foveomacular thickness, parafovea thickness and perifovea thickness. Preoperatively, visual acuity correlated with fovea thickness ($r = -0.4437$, $P = 0.0041$), and postoperatively ($r = -0.3345$, $P = 0.0349$). Preoperatively, visual acuity correlated with parafovea thickness ($r = -0.4160$, $P = 0.0076$), and postoperatively ($r = -0.3758$, $P = 0.0169$). However, no correlation was observed between preoperative BCVA and preoperative perifovea thickness ($r = -0.2609$, $P = 0.1040$). Also, there was not a significant correlation between postoperative BCVA and postoperative perifovea thickness ($r = -0.3101$, $P = 0.0515$). Conclusion: Vitrectomy combined with ILM and epiretinal membrane peeling can enhance visual acuity and improve macula morphology in the treatment of ERMs, while most of patients did not recover foveal depression after surgery.

Keywords: Idiopathic macular epiretinal membranes, OCT, retinal thickness, BCVA

Introduction

Epiretinal membrane (ERM) is considered one of the most common disorders found in vitreoretinal diseases. It results from the proliferation and migration of the fibrocellular lining in the internal limiting membrane (ILM) after posterior vitreous detachment, or from retinal breaks and detachments [1]. The hyperreflective band over the ILM can be visualized as the ERM on optical coherence tomography (OCT). Proliferation and contraction of the ERM can cause retinal changes like retinal layer thickening, surface wrinkling, distortion of the blood vessels, and macular cystic changes [2]. Besides, the junction of the photoreceptor ellipsoid zone (EZ) and the inner segment/outer segment (IS/OS) can also be disturbed by the traction of the inner retinal layers. These changes can lead to decreased visual acuity; produce visual symptoms such as central blurring, metamorphopsia, micropsia, macropsia, and monocular diplopia.

The prevalence of ERM is common in Asians especially in Chinese. The age-standardized and ethnicity-standardized prevalence is 12.1% for ERM. ERM prevalence is higher in Chinese (13.0%) compared with Malays (7.9%) or Indians (8.7%) [3], which was found to be 7.3% in urban Chinese [4], 6.0% in Australians [5] and 8.7% in Japanese [6]. Older age is one of the most sig-

nificant factors associated with the occurrence of primary ERM. Other factors associated with primary ERM were smoking, long axial length and cataracts.

OCT can elucidate the presence or absence of ERM, and objectively measure other effects of ERM on the retina, such as the loss of the foveal depression, macular thickening, the presence or absence of macular edema (e.g. cystoid macular edema), and any associated vitreous traction on the retina [7]. Pars plana vitrectomy (PPV) for idiopathic epiretinal membranes has been a common procedure to remove the ERM. The principal indication for PPV is decreased visual acuity with or without metamorphopsia. Therefore, we aim to evaluate the preoperative and postoperative aspects of ERM using OCT, and explore the underlying correlation with visual acuity.

Methods

This study was performed at the Eye Center, Renmin Hospital of Wuhan University, from July 2015 to May 2017. A series of 82 eyes in 78 patients were operated on with PPV and patients were followed up with comprehensive ophthalmologic examinations, including BCVA (standard logarithmic visual acuity chart), slit-lamp examination, intraocular pressure, fundus photography and OCT scans. They were examined 1 day or 2 days before surgery, 1 week, 1 month, 2 months, 3 months and 6 months after surgery. Patients underwent OCT with horizontal and vertical scans across the fovea center and 30° × 20° volume scan. The OCT imaging was performed in 320 separate patient visits. The majority of these visits were performed with a Zeiss Cirrus HD-OCT (Carl Zeiss Meditec, Inc., Dublin, CA, USA) device. Surgery was performed to peel ILM and ERM with a 23-gauge PPV stain with indocyanine green.

All the participants signed a written informed consent. Clinically identified idiopathic ERM (both symptomatic and asymptomatic) was the sole inclusion criterion. Exclusion criteria included macular hole, lamellar hole, traction retinal detachment, diabetic macular edema, and previous retinal surgeries or procedures [8, 9].

Statistical methods

For patients with idiopathic macular epiretinal membranes, the retinal thickness was divided into three parts (namely foveal thickness, parafovea thickness, perifovea thickness) and was compared before and after operation. BCVA and macular retinal thickness measured by OCT were followed in the first one week and at the sixth month. Obtained data was statistically processed with GraphPad Prism 5 software. BCVA (reported in decimals) and macular retinal thickness before and after operations were compared by t testing. If $P < 0.05$, the difference was regarded as having statistical significance. For the analysis on linear correlation between BCVA and macular thickness, Pearson's linear correlation coefficient analysis was used. When $P < 0.05$, there is an obvious linear correlation.

Results

There were eighty-two eyes from seventy-eight patients (male/female: 20/58) with unilateral or bilateral IMEM in this study. The mean age was 60 years (range: 40-75). All eyes received 23G vitrectomy combined with ILM peeling, no preoperative and intraoperative complications occurred.

The macular retinal thickness decreases after vitrectomy to ERMs

The macular retinal thickness significantly decreased after vitrectomy for the 78 patients with idiopathic macular epiretinal membrane. The preoperative and postoperative BCVA were 0.26 ± 0.16 and 0.36 ± 0.16. There was a statistically significant difference between preoperative and postoperative BCVA ($P < 0.0001$, $t = 9.843$). Mean preoperative foveal thickness was 506.41 ± 112.67 μm, whereas mean postoperative thickness was 442.39 ± 82.10 μm (decrease in foveal thickness of 64.02 μm on average). There was a significant difference ($P < 0.0001$, $t = 5.526$) in the reduction of central foveal thickness. The preoperative and postoperative parafovea thicknesses were 453.66 ± 79.36 and 409.95 ± 61.63 (decrease in parafovea thickness of 43.71 μm on average). There was also a statistically significant difference between preoperative and postoperative parafovea thickness ($P < 0.0001$, $t = 6.164$). Mean preoperative perifovea thickness was 365.93 ± 50.84 μm, whereas mean postoperative thickness was 356.76 ± 54.20 μm (decrease in perifovea thickness of 9.17 μm on average). However, there was no statistically significant

Table 1. Preoperative and postoperative changes of BCVA, Fovea thickness, Parafovea thickness and Perifovea thickness ($\bar{X}$ + S)

	Pre-operation	Post-operation	P	T
BCVA	0.26 ± 0.16	0.36 ± 0.16	< 0.0001	9.843
Foveal thickness	506.41 ± 112.67	442.39 ± 82.10	< 0.0001	5.526
Parafovea thickness	453.66 ± 79.36	409.95 ± 61.63	< 0.0001	6.164
Perifovea thickness	365.93 ± 50.84	356.76 ± 54.20	0.0919	1.724

Table 2. Six months after operation to idiopathic macular epiretinal membranes ($\bar{X}$ + S)

	Pre-operation	Post-operation	6 months follow up after operation
LogMAR BCVA	0.26 ± 0.16	0.36 ± 0.16	0.38 ± 0.13
Fovea (μm)	506.41 ± 112.67	442.39 ± 82.10	375.70 ± 72.26
Parafovea (μm)	453.66 ± 79.36	409.95 ± 61.63	373.10 ± 48.77
Perifovea (μm)	365.93 ± 50.84	356.76 ± 54.20	325.60 ± 35.20

difference between preoperative perifovea thickness and postoperative perifovea thickness (P > 0.05) (**Table 1**).

The BCVA greatly improves after vitrectomy to ERMs

Patients were followed up for 6 months. Comparing the improvement situation of visual function before and after operation in a 6 months follow-up, the BCVA increased from 0.26 ± 0.16 before operation to 0.36 ± 0.16 after operation, which shows that it increased 0.1. While, the BCVA increased from 0.36 ± 0.16 after operation to 0.38 ± 0.13 in the first month of follow-up, which shows an increase of 0.02. The overall vision of patients improved greatly after operation while the reduction of macular thickness is quick to occure in the first month after operation (**Table 2**).

The recovery of vision after vitrectomy to ERMs is associated with the profile of macular morphological changes before operation

According to the different profiles of macular morphological changes before ERM operation, macular morphological changes are categorized into types of normal (C), macular edema (D), foveal cyst (E), and macular pseudohole (F) (**Figure 1**). All the patients with ERM included 24 eyes in the normal fovea group, 39 eyes in the macular edema (ME) group, 9 eyes in the foveal cyst (FC) group, and 10 eyes in the macular pseudohole (MPH) group (**Tables 3**-**6**). Before and after operation among the four groups, the BCVA improved in all the groups. It is remarkable that the recovery of vision in the normal group is the quickest, and the patients with macular edema had the worst visual recovery. By comparing the fovea thickness before and after epiretinal membrane operation in four groups, the fovea thickness in the macular edema group and foveal cyst group is significantly thicker than before (P < 0.05), while the thickness in the other two groups has no significant difference. By comparing the parafovea thickness before and after epiretinal membrane operation in the four groups, the parafovea thickness in the macular edema and macular pseudohole group was significantly thicker than before. When comparing the perifovea thickness, only the thickness in the macular pseudohole group significantly decreased.

BCVA has a linear correlation with fovea and parafovea thickness

Pearson's linear correlation coefficient analysis was used for the linear correlation between BCVA and macular thickness. There is a significant correlation between pre-operation and post-operation thickness in the analysis of BCVA, fovea thickness, parafovea thickness and perifovea thickness. According to the analysis of linear correlation between BCVA before operation and macular central foveal thickness, parafovea thickness, perifovea thickness before operation, between BCVA 1 week after operation and macular central foveal thickness, parafovea thickness, perifovea thickness, results show that BCVA before operation has linear correlation with fovea thickness before operation (r = -0.4437 and P = 0.0041 < 0.05 showing significant correlation), preoperative BCVA has linear relation with preoperative parafovea thickness (r = -0.4160 and P = 0.0076 showing significant correlation), postoperative BCVA has linear relation with postoperative fovea thickness (r = -0.3345, P =

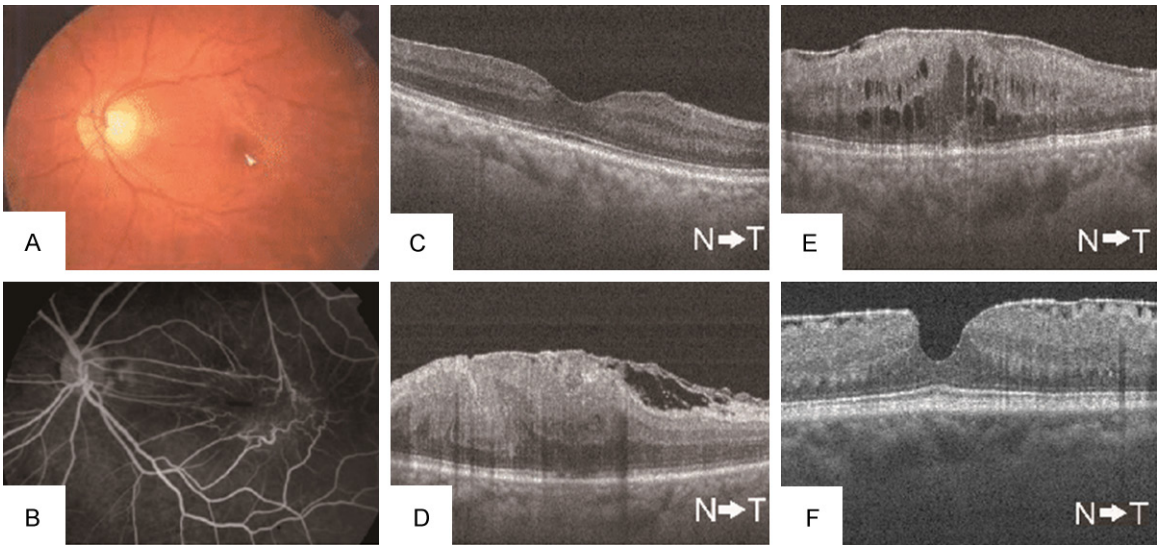

Figure 1. Observation of the vessel transformation of patients with idiopathic macular epiretinal membranes (A, B). Four different profiles of macular morphological changes before ERM operation. Macular morphological changes are categorized into types of normal (C), macular edema (D), foveal cyst (E), macular pseudohole (F).

Table 3. Comparison of the pre-operation and post-operation BCVA in four groups ($\bar{X}$ + S)

Groups	Time	BCVA	t	P
Normal N = 24 (eyes)	Pre-operation	0.29 ± 0.18	6.765	< 0.0001
	Post-operation	0.41 ± 0.18		
macular edema N = 39 (eyes)	Pre-operation	0.23 ± 0.12	5.902	< 0.0001
	Post-operation	0.32 ± 0.14		
foveal cyst N = 9 (eyes)	Pre-operation	0.31 ± 0.23	2.574	0.0498
	Post-operation	0.39 ± 0.20		
macular pseudohole N = 10 (eyes)	Pre-operation	0.29 ± 0.11	2.658	0.0376
	Post-operation	0.38 ± 0.14		

Table 4. Comparison of the pre-operation and post-operation fovea thickness (μm) in the four groups ($\bar{X}$ + S)

Groups	Time	Fovea (μm)	t	P
Normal N = 24 (eyes)	Pre-operation	377.25 ± 84.36	1.594	0.2092
	Post-operation	357.00 ± 67.51		
macular edema N = 39 (eyes)	Pre-operation	536.00 ± 103.76	4.363	0.0002
	Post-operation	465.72 ± 68.36		
foveal cyst N = 9 (eyes)	Pre-operation	574.85 ± 88.62	3.056	0.0223
	Post-operation	475.86 ± 88.59		
macular pseudohole N = 10 (eyes)	Pre-operation	418.63 ± 53.55	1.580	0.1582
	Post-operation	382.88 ± 58.76		

0.0349), postoperative BCVA has linear relation with postoperative parafovea thickness (r = -0.3758, P = 0.0169), but there was no correlation in the other cases (P > 0.05) (**Figure 2**).

Discussion

ERM leads to retinal traction and macular morphological changes significantly associated

Table 5. Comparison of the pre-operation and post-operation parafovea thickness (μm) in the four groups ($\bar{X}$ + S)

Groups	Time	Fovea (μm)	t	P
Normal N = 24 (eyes)	Pre-operation	375.25 ± 64.65	1.848	0.1617
	Post-operation	350.75 ± 43.13		
macular edema N = 39 (eyes)	Pre-operation	478.48 ± 83.27	5.125	< 0.0001
	Post-operation	428.88 ± 62.97		
foveal cyst N = 9 (eyes)	Pre-operation	468.43 ± 48.23	1.534	0.1760
	Post-operation	427.57 ± 48.59		
macular pseudohole N = 10 (eyes)	Pre-operation	402.38 ± 32.00	4.281	0.0036
	Post-operation	365.00 ± 18.37		

Table 6. Comparison of the pre-operation and post-operation perifovea thickness (μm) in the four groups ($\bar{X}$ + S)

Groups	Time	Fovea (μm)	t	P
Normal N = 24 (eyes)	Pre-operation	327.00 ± 54.35	1.607	0.2065
	Post-operation	313.25 ± 40.21		
macular edema N = 39 (eyes)	Pre-operation	383.08 ± 54.85	1.426	0.1667
	Post-operation	372.96 ± 58.00		
foveal cyst N = 9 (eyes)	Pre-operation	358.29 ± 10.29	0.674	0.5253
	Post-operation	369.71 ± 41.62		
macular pseudohole N = 10 (eyes)	Pre-operation	338.50 ± 27.68	2.861	0.0243
	Post-operation	318.25 ± 16.33		

with BCVA decrease. Meanwhile, retinal traction and morphological changes that occur for a long time can cause functional damage, resulting in vision decay, metamorphopsia and sometimes monocular diplopia.

Functional results

Currently, vitrectomy combined with macular membrane dissection for idiopathic epiretinal macular membrane has been an effective treatment for many years. It has good performance in the improvement of vision in 80% to 90% of patients. Besides visual acuity improvement, other clinical symptoms such as metamorphopsia and diplopia are often reduced postoperatively. In our study, the postoperative BCVA significantly improved compare with preoperative BCVA ($P < 0.0001$). In the end of the follow-up, among the 78 patients with idiopathic macular epiretinal membrane, the visual acuity continually recovers, although the macular thickness change is limited.

Macular morphological changes results

Since OCT was introduced, it has been an extremely useful method for making diagnoses of macular epiretinal membranes. The shrinkage of epiretinal membrane may result in a thickness increase in the macular area. Sometimes macular edema continuously exists even after epiretinal membrane dissection [10]. Postoperative macular retinal thickness measurements made by OCT revealed a significant decrease. A significant difference was observed in the reduction of central foveal thickness, parafovea thickness and perifovea thickness. According to the different profiles of macular morphological changes before ERM operation, all patients are categorized into four groups, including the normal fovea group, macular edema group, foveal cyst group and macular pseudohole group. By comparing these groups, we found that there is a close connection between visual acuity and macular thickness which is related to the traction of macular epiretinal membranes.

Our results showed that macular retinal thickness significantly reduced after epiretinal membrane peeling, although most macular retinal thickness does not recover to normal. Most patients did not recover normal macu-

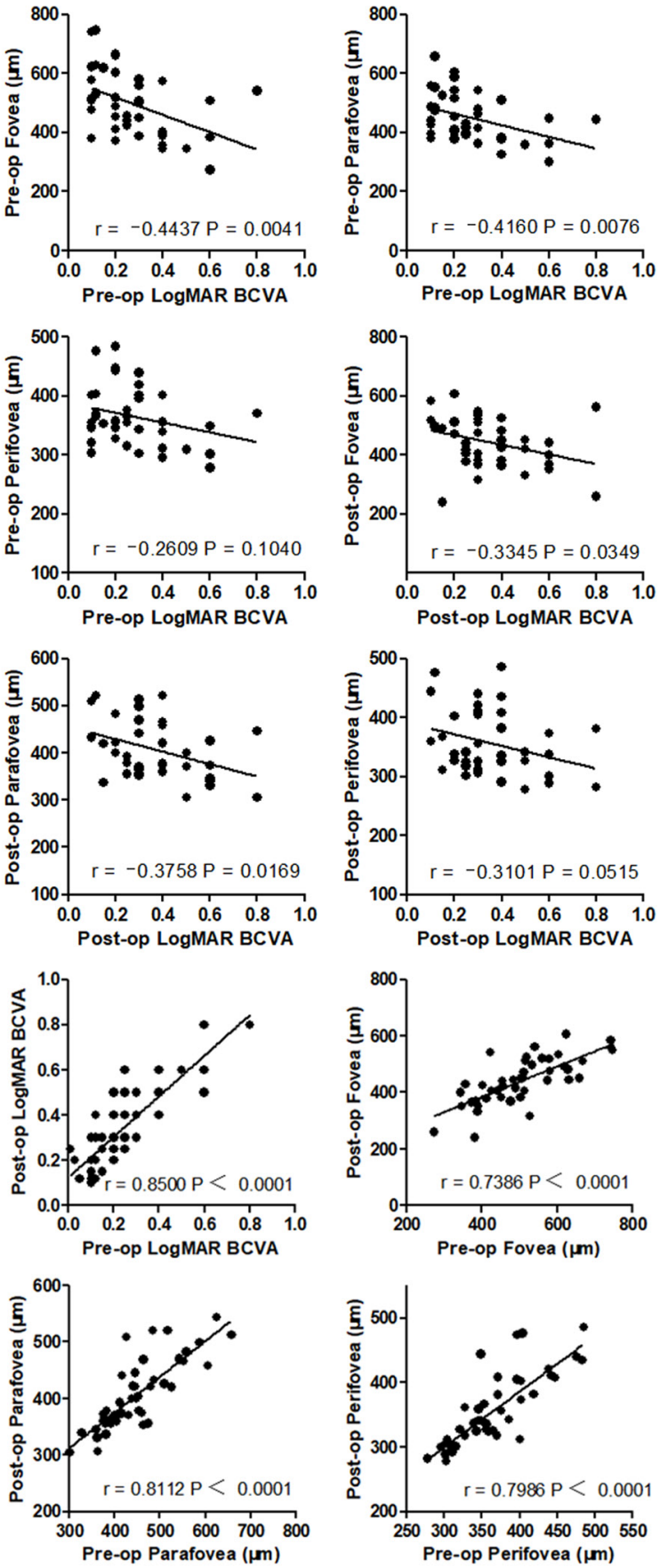

Figure 2. Linear correlation relationship between vision and macular retinal thickness assessed with optical coherence tomography (OCT).

lar microanatomy, the vitrectomy for epiretinal membrane is safe and effective in terms of the functional recovery [11]. This finding is in agreement with another study on epiretinal membrane peeling [12]. Chuan Wen and other researchers conducted a series of retrospective case studies in 60 eyes followed for 1 year, the corresponding analysis of BCVA and OCT on the external limiting membrane (ELM) and EZ had better integrity where the visual acuity was better, and found that cystic changes in the macula were not related to vision [13]. This reminds us that the integrity of the ELM and EZ plays an important role in the recovery of postoperative visual acuity.

Whether ILM peeling is desired in the treatment for ERM is still controversial [14]. It has been reported that ILM peeling associated with ERM removal does not improve the vision but may reduce the later recurrence rate [15].

There are still some limitations in our research. It is a retrospective study. When macular morphological changes are categorized into the different types of normal, macular edema, foveal cyst, macular pseudohole, certain groups did not have enough cases for stastical power. We desired to enlarge the numbers in each case in order to assess the relationship between BCVA and the prediction location of idiopathic macular epiretinal membranes.

Conclusion

Vitrectomy has certain curative effects in the treatment of ERM, the BCVA greatly improves and the macular retinal thickness is significantly decreases after vitrectomy for ERM patients. Despite the fact that postoperative BCVA was improved significantly in the study, most macular retinal thickness did not recover to normal. Moreover, this also requires further study to find out why macular retinal thickness does not influence the functional results, as well as the best way to improve the recovery of retinal thickness.

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Disclosure of conflict of interest

None.

Abbreviations

BCVA, Best corrected visual acuity; ERM, Epiretinal membrane; OCT, Optical coherence tomography; ME, Macular edema; FC, Foveal cyst; MPH, Macular pseudohole; ILM, Internal limiting membrane.

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References

[1] Massin P, Allouch C, Haouchine B, Metge F, Paques M, Tangui L, Erginay A and Gaudric A. Optical coherence tomography of idiopathic macular epiretinal membranes before and after surgery. Am J Ophthalmol 2000; 130: 732-739.

[2] Shahzadi B, Rizvi SF, Latif K, Murtaza F and Naz S. Visual and anatomical outcomes following idiopathic macular epiretinal membrane surgery. J Coll Physicians Surg Pak 2016; 26: 971-974.

[3] Cheung N, Tan SP, Lee SY, Cheung GCM, Tan G, Kumar N, Cheng CY and Wong TY. Prevalence and risk factors for epiretinal membrane: the singapore epidemiology of eye disease study. Br J Ophthalmol 2017; 101: 371-376.

[4] Ye H, Zhang Q, Liu X, Cai X, Yu W, Yu S, Wang T, Lu W, Li X, Hu Y, Yang B and Zhao P. Prevalence and associations of epiretinal membrane in an elderly urban Chinese population in China: the Jiangning Eye Study. Br J Ophthalmol 2015; 99: 1594-1597.

[5] McCarty DJ, Mukesh BN, Chikani V, Wang JJ, Mitchell P, Taylor HR and McCarty CA. Prevalence and associations of epiretinal membranes in the visual impairment project. Am J Ophthalmol 2005; 140: 288-294.

[6] Noda Y, Yamazaki S, Kawano M, Goto Y, Otsuka S and Ogura Y. Prevalence of epiretinal membrane using optical coherence tomography. Nippon Ganka Gakkai Zasshi 2015; 119: 445-450.

[7] Do DV, Cho M, Nguyen QD, Shah SM, Handa JT, Campochiaro PA, Zimmer-Galler I, Sung JU and Haller JA. The impact of optical coherence tomography on surgical decision making in epiretinal membrane and vitreomacular traction. Trans Am Ophthalmol Soc 2006; 104: 161-166.

[8] Mathews NR, Tarima S, Kim DG and Kim JE. Foveal contour changes following surgery for idiopathic epiretinal membrane. Invest Ophthalmol Vis Sci 2014; 55: 7754-7760.

[9] Pilli S, Lim P, Zawadzki RJ, Choi SS, Werner JS and Park SS. Fourier-domain optical coherence tomography of eyes with idiopathic epiretinal membrane: correlation between macular morphology and visual function. Eye (Lond) 2011; 25: 775-783.

[10] Frisina R, Pinackatt SJ, Sartore M, Monfardini A, Baldi A, Cesana BM, Semeraro F, Bratu A and Parolini B. Cystoid macular edema after pars plana vitrectomy for idiopathic epiretinal membrane. Graefes Arch Clin Exp Ophthalmol 2015; 253: 47-56.

[11] Mazit C, Scholtes F, Rabaut C, Jallet G and Cochereau I. Assessment of macular profile using optical coherence tomography after epiretinal membrane surgery. J Fr Ophtalmol 2008; 31: 667-672.

[12] Pournaras CJ, Emarah A and Petropoulos IK. Idiopathic macular epiretinal membrane surgery and ILM peeling: anatomical and functional outcomes. Semin Ophthalmol 2011; 26: 42-46.

[13] Chang YC, Lin WN, Chen KJ, Wu HJ, Lee CL, Chen CH, Wu KY and Wu WC. Correlation between the dynamic postoperative visual outcome and the restoration of foveal microstructures after macular hole surgery. Am J Ophthalmol 2015; 160: 100-106, e101.

[14] Oh HN, Lee JE, Kim HW and Yun IH. Clinical outcomes of double staining and additional ILM peeling during ERM surgery. Korean J Ophthalmol 2013; 27: 256-260.

[15] Chang S. Controversies regarding internal limiting membrane peeling in idiopathic epiretinal membrane and macular hole. Retina 2012; 32 Suppl 2: S200-203; discussion S203-204.