· Original article ·

Anatomic and functional results after macula-off retinal detachment surgery

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累及黄斑视网膜脱离术后解剖学改变和功能恢复情况

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摘要

目的:OCT 观察累及黄斑视网膜脱离行巩膜外加压术后 5a 黄斑情况。分析脱离时间及术后 5a 黄斑 OCT 及视功能的相关性。

方法:回顾性分析 47 例 47 眼,累及黄斑视网膜脱离行巩膜外加压术后 5a OCT, 视功能及脱离时间,并行统计学分析。

结果:视网膜脱离时间<7d 的黄斑厚度(226 ±88μm)较脱离时间>7d 黄斑厚度 (209 ±76μm) 厚, 但无统计学意义。而术后复位的黄斑厚度和视力呈正相关(Pearson correlation test, R=1,P=0.01)。脱离时间<7d 组视力(0.53)明显好于脱离时间>7d 组视力(0.25),明显统计学差异(t-test, P=0.008)。5 例(10%)患者发现黄斑区结构异常,包括 4 例 IS/OS 层断裂,同时伴有外界膜的断裂(8.5%),且术后 5a 平均视力(0.15)低于两组的平均视力。

结论:脱离时间的长短严重影响视功能的恢复、术后黄斑的厚度及黄斑结构的改变。累计黄斑视网膜脱离手术尽可能在脱离时间<7d 内完成。对于视力恢复较差者,建议行 OCT 检查。

关键词:长期;黄斑脱离;视网膜脱离;光学相干断层成像术;手术

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Abstract

• AIM: To observe the macula structure of the macula-off rhegmatogenous retinal detachment (RRD) with optical coherence tomography (OCT) 5 years after successful scleral buckling (SB) surgery and to analyze the correlation between the duration of macular detachment (DMD) and postoperative visual acuity with OCT image.

• METHODS: Forty-seven eyes of 47 patients with macula-off RRD were retrospectively studied and follow-up was carried out for a period of 5 years. The correlation among the postoperative best-corrected visual acuity (VA), the DMD and the microstructural findings with OCT at the fovea were evaluated.

• RESULTS: The sub-acute RRD (DMD < 7d) shows a greater foveal thickness (226 ±88μm) than the prolonged one (DMD > 7 days) (209 ±76μm) with no statistical difference (P=0.791). Meanwhile, the sub-acute RRD had better mean final VA 0.53, compared with the prolonged one of 0.25, with significant difference (Student's t-test, P=0.008). Among 47 eyes, foveal anatomic abnormalities were detected in 5 eyes (10%); disruption of the junction between the photoreceptor inner and outer segments (IS/OS) in 4 eyes, and with a disrupted external limiting membrane (ELM) also (8.5%); and the mean VA of these 5 patients was 0.15 lower after 5 years.

• CONCLUSION: Sub-acute macula-off RRD has a better impact on the final visual recovery than the prolonged one. Furthermore, the retinal thickness in the fovea was positively correlated to the postoperative VA. The disrupted inner segment/outer segment (IS/OS) junction could be restored in the patients without disrupted ELM signals at the initial examination. The duration of macula-off RRD within 7d had fewer disrupted inner segment/outer segment (IS/OS) junction with disrupted ELM signals than those for more than 7d. It is recommended to perform OCT in cases where VA was not improved as expected.

• KEYWORDS: long-term; macula-off; retinal detachment; optical coherence tomography; surgery
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INTRODUCTION

Patients with macula - off rhegmatogenous retinal detachments (RRDs) haveincomplete visual recovery after successful anatomic attachment[1-3]. Postoperative pathologies that may influence visual recovery include epiretinal membranes, pigment migration[4], cystoid macular edema[5], and retinal folds[6]. In these cases, subtle changes in the foveal structure, which may cause visual disturbances, can hardly be identified during standard clinical examinations such as slit - lamp biomicroscopy or binocular indirect ophthalmoscopy.

The introduction of optical coherence tomography (OCT)[1-3] provides a new way to obtain objective data of clinically hidden retinal structures. OCT has led to many new findings in studies of retinal abnormalities, especially of macular disorders[7-11]. Sometimes, the retina had already anatomically reattached as confirmed with indirect ophthalmolscopy[12-14]. But the functional visual improvement remains disappointing. In the current study, we retrospectively reviewed the patients after SB for macula-off RRD with OCT. Follow-up period was 5 years. Also we analyzed the relationship between the macular foveal thicknesses, the duration of (DMD), and improvement of postoperative VA.

SUBJECTS AND METHODS

Subject We retrospectively reviewed 418 RRD surgery cases. An intraoperative cryotherapy was implemented in all cases to achieve additional retinopexy. However, the surgical repair was either a radial or circumferential silicone sponge, none of them was treated by additional drainage of the subretinal fluid. We used extensive and exclusive criteria to complete the patient database. Only those eyes with a primary macula-off RRD, treated by scleral buckling (SB) surgery and with a follow-up at least 5 year, were included in this retrospective survey.

Study did not include: 1) RRD with macula-on detachment; 2) Additional ocular diseases affecting central visual function including severe macular degeneration; 3) Macular hole, optic atrophy or amblyopia; 4) Eyes with previous retinal surgery; 5) Eyes with a history of ocular trauma or complicated RRD such as those with giant retinal tear; 6) Eyes with proliferative vitreoretinopathy more than grade C3 or retinoschisis. Media opacities, *e. g.* significant cataracts, vitreous hemorrhage or significant central vitreous debris were also excluded because poor VA in these eyes could not be attributed solely to macular detachment, therefore the estimate of DMD may have been inaccurate. Additionally, patients did not accurately recall the time of onset of visual loss and some patients were incommunicative.

Methods All patients were examined according to the following factors: age of the initial presentation, gender, pre- and postoperative Snellen VA, the preoperative DMD. Snellen fraction visual acuities were converted to logMAR (logarithm of the minimum angle of resolution) units as described by Ferris *et al*[15] by taking the logarithm. Using this conversion, the VA values were converted to a linear scale for statistical analysis, in which 1.0 VA has a logMAR value of 0, 0.5; a value of 0.3, 0.25; a value of 0.6, 0.1; a value of 1.0[15]. Counting fingers VA was converted to a Snellen equivalent by recording the counting finger distance as the numerator with a denominator of 200. Patients with hand motion VA were only assigned a logMAR value of 3.0[16]. Then the log-MAR statistic results were transformed back to Snellen equivalents.

A mandatory preoperative fundus drawing demonstrated the characteristics of each RRD as well as the number, type and meridional location of retinal breaks. Intraoperative findings, immediate postoperative retinal status, as well as intraoperative and postoperative complications, were also obtained from the patient's medical records. Missing clinical information was collected from other central, regional and private hospitals where these patients had been followed-up, and from private ophthalmologists responsible for the referral and follow-up.

Forty-seven eyes met the strict inclusion criteria and were divided into two groups: DMD of up to 7d, and more than 7d. The follow-up period ranged from 5 to 7 years with a mean of 6 years. Visual improvement was defined as an increase in 5-year postoperative VA by 2 lines or more. No significant intraoperative complication, such as an increase in the intraocular pressure occurred in any of the 47 eyes.

Examination of macula was performed by Stratus OCT and Cirrus HD Oct (Carl Zeiss, Germany) after 5 years follow-up with 2.8- or 5-mm long vertical and horizontal scans through the fovea. The low reflective region observed by OCT was defined as an accumulation of subretinal fluid according to previous reports[17, 18]. The relationship between the present subretinal fluid, DMD, and the improvement of postoperative VA was studied.

Statistical Analysis Statistical analysis of the correlation between DMD, preoperative VA and 5 years postoperative best-corrected VA was carried out using the SPSS for Windows, version 12.0. All tests were 2-tailed, and a P value less than 0.05 was considered significant.

RESULTS

Totally out of 418 patients reviewed, only 47 patients met the criteria. The 47 patients were followed up for 5 years, including 14 females and 33 males of an age between 12 and 90 years (mean 61.85 ±16.45years). All the patients were examined with OCT.

There were no significant intraoperative complications, such as subretinal hemorrhage or retinal incarceration.

Patients were divided into two groups depending on a DMD of 7 days or less ($n=36$; subacute) or a DMD of more than 7d ($n=11$; prolonged).

The mean preoperative VA (0.06) of the subacute group was lower than that of the prolonged group VA (0.14). There was no statistical difference between the two groups (Student's *t* test, $P=0.098$). The difference in the mean final VA after SB surgery between eyes with acute DMD 0.53 ±0.06 and eyes with prolonged DMD 0.25 ±0.10 was significant (Student's *t* test, $P=0.008$). A final VA of more than 0.4 was achieved in 28 eyes with an acute DMD, but only in 7 eyes with a prolonged DMD (χ^2 test, $P<0.001$, Table 1).

VA improved by a mean value of 1.60 ±0.02 lines during the follow-up period from 0.32 ±0.08 of the 3-month follow-up to 0.46 ±0.10 of the 5-year follow-up for all patients. VA was shown to improve in eyes with both acute and prolonged DMD at the 5-year follow-up. VA was obviously improved in the first 7d after surgery, and then kept increasing till the end of the follow-up period. Eyes with a DMD of ≤7d had significantly better VA than eyes with a DMD of more than 7d (Figure 1).

Table 1　The effect of DMD on preoperative and postoperative VA

DMD(d)	*n*	Preop. mean VA	Postop. mean VA[1]	Patients with VA>0.4[2 b]
≤7	36	0.06(1.22 ±0.44)	0.53(0.28 ±0.06)	28(77.7%)
>7	11	0.14(0.85 ±0.05)	0.25(0.60 ±0.11)	7(63.6%)

DMD: Duration of macular detachment; VA assessed by Snellen charts; Figures in parentheses indicate mean logMAR ±SD; [1]Student's *t* test, $P=0.008$; [2]χ^2 test, [b]$P<0.001$.

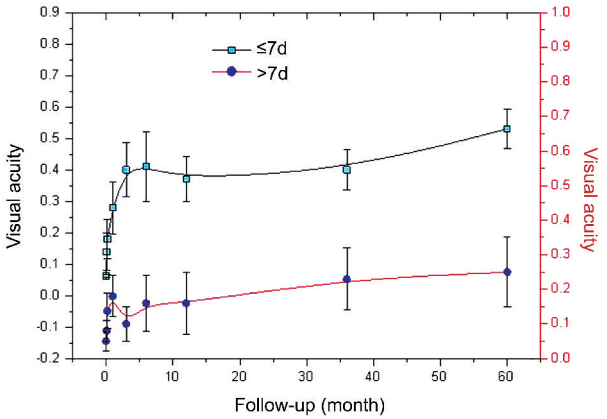

Figure 1　Mean increase in VA of the two groups (DMD≤7d *vs* >7d) for a follow-up period of 5 years.

Foveal thickness of these 47 patients was measured during a follow-up period of 5 years by OCT. We found that the foveal thickness of the subacute group presented thicker than that of the prolonged group during a follow-up period of 5 years, but there was no statistical difference in the foveal thickness outcome between patients in the subacute group and the prolonged group ($P=0.791$, Table 2). While the mean final VA in the subacute group was 0.53, the prolonged group was only 0.25. The difference of final VA between these two groups was significant (Student's *t* test, $P=0.008$, Table 1). Twenty-eight patients out of 36 (77.7%) received scleral buckle surgery within 7d and have achieved a VA of more than 0.4. In contrast, only 7 of 11 patients (63.6%) who received surgery at more than 7d obtained 0.4 vision (Chi-squared test, $P<0.001$, Table 1). Foveal anatomic abnormalities were detected in 5 eyes (10%), all these 5 eyes were in the group DMD> 7 days, including disruption of the junction between the photoreceptor inner and outer segments (IS/OS) in 4 eyes (8.5%), and the 4 eyes (8.5%) had a disrupted external limiting membrane (ELM); and the mean VA of these 5 patients was quite low only 0.15 after 5 years. Of the 5 eyes, 1 patient with subretinal fluid and 1 patient with epiretinal membrane (ERM) were not detected by indirect ophthalmoscopy, but were detected by the OCT.

Our study also showed the postoperative thick foveal group had better postoperative VAs than the thin one, and with a positive correlation after 5- year follow-up (Table 3).

Table 2　Statistical analysis of foveal thickness and DMD

($\bar{x}\pm s$, μm)

DMD(d)	*n*	Foveal thickness
≤7	36	226±88
>7	11	209±76

DMD: Duration of macular detachment; Student's *t* test, $P=0.791$.

Table 3　The relevance between DMD and postoperative VA

DMD(d)	*n*	Foveal thickness(μm)	Postop. mean VA[1]
≤7	36	226 ±88	0.53(0.28 ±0.06)
>7	11	209 ±76	0.25(0.60 ±0.11)

DMD: Duration of macular detachment; [1]Pearson correlation test, R=1, $P=0.01$.

DISCUSSION

Nearly all symptomaticRRDs Progress to total blindness unless they are repaired. Until 70 years ago, RRD was almost an incurable disorder. Nowadays the modern technical advances and better understanding of the pathogenesis of RRD have lead to excellent results especially in anatomically[19-21]. However, the functional improvement in vision remains disappointing, especially if the retina has already anatomically reattached with indirect ophthalmolscope examination. In our study, we retrospectively reviewed the visual recovery with a 5 years' studies follow-up after SB surgery in macula-off retinal detachment. We detected the macular structure with OCT and analyzed the effect of factors on final visual outcome.

Patients with macula-off RRD can have poor visual recovery, specific color vision defects, or postoperative metamorphopsia despite successful retinal reattachment[22-24]. In these cases, subtle changes in the foveal structure, which may cause visual disturbances, could hardly be identified during standard clinical examinations such as slit-lamp biomicroscopy or binocular indirect ophthalmoscopy.

OCT is introduced into clinical practice[9] and provides a new tool to obtain objective data on clinically hidden retinal structures. OCT revealed non-invasive, high-resolution tomographic images of the retina in a short period of time. New aspects of vitreo-retinal disease have been revealed by this means. In cases of RRD[13,17,18,25,26], OCT is a effective approach because of its unique effective observation of the three-dimensional retinal structure *in vivo* at nearly histopathologic levels. The subfoveal clear space observed with OCT was defined as residual subretinal fluid[13].

When OCT signals are generated, thechanges in the refractive index control most of the signals[27]. Thus, refractive index changes give off high signals at the borders. Cases with residual subretinal fluid have a highly refractive layer at the outer surface of the neurosensory retina; thus, the layer indicates the presence of a refractive index change. This change is believed to to indicate the existence of subretinal fluid. In some cases, this clear space is preoperatively observed and narrowed after surgery; thus, this clear space

must contain subretinal fluid. In fact, if the clear space contains subretinal fluid, it is important to identify it because the photoreceptor layer produces a low signal in a normal eye on OCT.

Foveal disorder observed with OCT after SB surgery was reported in 2007[12]. Persistent residual subretinal fluid was revealed by OCT in a short time follow-up[13,14] after surgery. Microstructural changes within the photoreceptor layer were reported 62% - 66. 7%. Disrupted inner segment/outer segment (IS/OS) junction was noted 43% - 53. 3%, in which 33. 3% - 39% with external limiting membrane discontinued[28-33]. In our study, we still found few cases had persistent residual subretinal fluid even after 5 years post-operation by OCT. Furthermore we also observed foveal anatomic abnormalities in 5 eyes (10%); disruption of the junction between the photoreceptor IS/OS in 4 eyes (8.5%), of which all had a disrupted external limiting membrane (ELM). Our foveal anatomic abnormality rates are lower than those of the previous studies. This might be due to the 5-year follow-up of our patients, comparing to the mostly 1-year follow-up in the previous studies. We assumed the photoreceptor IS/OS junction could be restored in the eyes with a disrupted back-reflection line from the IS/OS junction during the long term follow-up period, although there was no disrupted ELM signals at the initial examination. Of the eyes with disrupted back-reflection lines from both IS/OS junction and ELM at the initial examination, the photoreceptor layer was not restored completely after the surgery[33].

Long-term duration of DMD can cause photoreceptor apoptosis, and further it causes neurosensory thinning and dystrophy. The relatively thicker neurosensory of the foveal had a better BCVA compared to the thinner one. Hence we might conclude that the thinner fovea with macular atrophy had a poor VA, while the thicker one had a better VA. The retinal thickness in the fovea and the postoperative VA were positively correlating[24]. In our study, we found out that the retina reattached anatomically in 47 patients with the 5-year follow-up after surgery, and the VA of some patients was not good. Our results showed that a recovery of VA (0.4) or even better occurred in 77.7% in the subacute group (28/36), and 63. 6% in the prolonged one (7/11). This result was comparable with other series, which reported a return of central VA of 0.4 or even greater between 37 to 60% patients[34,35]. The group with thicker forveal had better VA than the thinner one. Foveal thickness turned thin after retina recovery, it might because the cone /rod cell apoptosis. These changes also detected by OCT.

To quantify the VA changes after the reattachment of the retina, the 3-month and 5-year post-operative visual improvements were compared. But in previous studies the functional gain was presented only in a short-term follow-up of 4-6 months[36,37]. Our present study showed that the mean VA of a 3-month follow-up was significantly lower than that of the 5-year follow-up (Student's t test, $P<0.001$).

In conclusion, this study shows that the primary macular-off RRD of less than 7 days had a great statistical impact on the final visual recovery. It should be noted that visual function after reattachment may continue to improve over a long period of time. The disrupted IS/OS junction could be restored in the patients without disrupted ELM signals at the initial examination, whereas the ones with the disrupted ELM signals could not be done. The duration of macula-off RRD within 7 days had fewer disrupted IS/OS junction with disrupted ELM signals comparing with the ones more than 7 days.

We strongly recommend OCT for patients whose retina had anatomic reattachment successfully, but the achieved VA was not so good. Applying OCT makes it possible to find out the reason of poor VA, even long period of time after operation. This study may provide useful guidelines for the clinical management of macula-off RRD as well as for assessing the potential possibilities of visual recovery of patients after successful SB.

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