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Intact Ellipsoid Zone and External Limiting Membrane are Good Prognostic Factors after Successful Repair of Rhegmatogenous Retinal Detachment

Kai-Chun Cheng[1,2], Kai-Hung Cheng[3,4], Kai-Yuan Cheng[5], Kuo-Jen Chen[1] and Wen-Chuan Wu[2,6*]

[1]*Department of Ophthalmology, Kaohsiung Municipal Hsiao-Kang Hospital, Kaohsiung, Taiwan*

[2]*Department of Ophthalmology, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan*

[3]*Division of Cardiology, Department of Internal Medicine, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan*

[4]*Faculty of Medicine, College of Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan*

[5]*Department of Otolaryngology, Ministry of Health and Welfare Pingtung Hospital , Pingtung, Taiwan*

[6]*Department of Ophthalmology, Faculty of Medicine, College of Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan*

[*]**Corresponding author:** Wen-Chuan Wu, Department of Ophthalmology, Kaohsiung Medical University Hospital, No.100, Zihyou 1st Road, Sanmin District, Kaohsiung 807, Taiwan, Tel: 886-7-3214573; Fax: 886-7-3156413; E-mail: ufping64@ms5.hinet.net

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Abstract

Rhegmatogenous retinal detachment (RRD) is a vision-threatening disorder. Although successful repair of RRD, incomplete visual recovery, color vision defects, or persistent metamorphopsia may be still persist. Recent advances in retinal imaging have improved resolution to survey retinal pathologic changes. Spectral-domain optical coherence tomography (SD-OCT) is a non-contact real-time system which provides a rapid sweep of serial retinal scans that facilitates improved visualization of foveal microstructural changes. Several studies reported subtle foveal changes after successful surgical management of RRD, such as disruptions of the ellipsoid zone and disruptions of the external limiting membrane (ELM). These abnormalities were associated with decreased postoperative visual acuity. The integrity of the ellipsoid zone and ELM seems critical for predicting the better visual recovery after anatomically successful rhegmatogenous retinal detachment repair.

Keywords: Macular; Ellipsoid zone; External limiting membrane; Rhegmatogenous retinal detachment

Commentary

Rhegmatogenous retinal detachment (RRD) is a sight-threatening disorder. Although the anatomical success rate of retinal reattachment is high after operation [1], poor visual recovery, color vision defects, or persistent metamorphopsia may be encountered over time even after successful surgery for rhegmatogenous retinal detachment (RRD), particularly in cases of macula-off retinal detachment, suggesting the presence of microstructural macular damage that standard clinical examinations such as slit-lamp biomicroscopy or binocular indirect ophthalmoscopy could not discover [2]. Pastor et al demonstrated that there were only 42% of all RRD eyes getting 20/40 vision or better postoperatively, and only 37% achieving 20/50 vision or more postoperatively in macula-off retinal detachments [3].

Recent technologic development in retinal imaging have improved fundus examinations. Spectral-domain optical coherence tomography (SD-OCT) is a noninvasive real-time system that is increasingly used for understanding macular microstructure and evaluating the recovery process after surgical repair of RRD.

The advances of spectral-domain OCT (SD-OCT) led to a 50-fold faster data obtainment speed than using time- domain OCT ,which decreased motion artifacts and significantly ameliorated visualization of the photoreceptor layer using an axial resolution of 4 to 6 μm [4]. The Spectralis type (Heidelberg Engineering, Heidelberg, Germany), which combines software with an eye movement-tracking function, can operate serial scans at the same site, thus providing precise diagnosis of changes happening at assigned retinal location [5]. Therefore, SD-OCT imaging allows alternative opportunities to better understand the inconsistency between morphologic and functional outcomes after retinal detachment surgery.

The photoreceptors play an important role in maintaining macular function, and the ellipsoid zone probably reflects its function [6]. Recently external limiting membrane (ELM), which represents a linear confluence of junctional complexes between Müller cells and photoreceptors composed of photoreceptor cell bodies and the photoreceptor inner segment (IS) myoid part, has been thought as another important factor for survival of photoreceptor cells, and the integrity of the ELM is essential for visual restoration [7].

RD induces detachment of the outer segment (OS) of photoreceptors from the retinal pigment epithelium (RPE) and cuases degeneration and apoptosis of OS photoreceptors. Thus it disturbs normal OS renewal and leads to OS shortening and finally degeneration [8]. It also induces complex cellular responses in several cell types (e.g., photoreceptors, retinal pigment epithelium, Müller cell, and so on) throughout the retina due to separation of the neural retina from the RPE [9]. Previous studies investigated in animal and human eyes that retinal detachment induced apoptosis of photoreceptors in the early stage of the process. Apoptosis was identified at 24 h, peaked at 2 days, and declined 1 week later after RD [10]. Retinal detachment also causes a variety of cellular changes including photoreceptor degeneration, remodelling of neuron synapses, hypertrophy, and proliferation of the Müller cells leading to sub retinal fibrosis and proliferative vitreoretinopathy [11]. Previous experimental studies have demonstrated that the decreased OS length and the degenerated photoreceptor OS occur instantly after RD [8]. Apoptosis of the photoreceptor cells also occurs quickly after detachment [12] and thus leads to gradually loss of photoreceptors in eyes with prolonged RD [13].

The reversibility of the subsequent decrease in best-corrected visual acuity (BCVA) was determined by the period of the interval for which the retina had been detached [8]. It is difficult to quantify photoreceptor apoptosis and degeneration in vivo. Wakabayashi et al. [7] suggested that disruptions to both the ellipsoid zone and the ELM at the fovea implied that the anatomic changes in the photoreceptor layer extended from the photoreceptor inner segment/outer segment (IS/OS) level toward the photoreceptor cell bodies and Müller cell cone at the foveola. On the contrary, an intact ELM with a disrupted IS/OS junction implied that the morphologic changes were limited to the photoreceptor IS/OS level without extension to the cell bodies. Wakabayashi et al also proposed that 64% of eyes with an intact ELM and a disrupted ellipsoid zone (this band was also previously referred to as the photoreceptor inner and outer segment (IS/OS) junction) finally achieved complete restoration of the ellipsoid zone which indicated that recovery of the photoreceptor layer can occur in patients in which the degenerative changes have not yet extended to the photoreceptor cell bodies. In contrast, patients with disruption of both the ellipsoid zone and ELM may not achieve complete restoration of the microstructures in the photoreceptor layer even after anatomically successful repair of RD. Therefore, the extent of microstructural changes may associated with different level in recovery of BCVA.

Clinically some patients who accepted surgery for rhegmatogenous retinal detachment (RRD) have poor visual recovery. Several factors affecting postoperative visual acuity have been widely debated that are important points of concern for retinal surgeons. Factors reportedly correlated with visual improvement following operation for macula-off RRD include age, preoperative visual acuity [14] duration of macular detachment [15] and height of macular detachment [16]. Clinically detectable morphorlogic abnormalities such as cystoid macular edema, epiretinal membrane, and persistent macular subretinal fluid can cause poor recovery of postoperative visual acuity [17,18]. Even without cystoid macular edema, epiretinal membrane and macular subretinal fluid, prolonged visual impairment can occur during long-term follow-up. Previous studies using SD-OCT have demonstrated that the integrity of the ellipsoid zone and external limiting membrane(ELM) may be important predictors of postoperative visual outcome following anatomically successful rhegmatogenous retinal detachment repair [19,20]. Gharbiya et al. have suggested that using SD-OCT to evaluate the appearance of the outer retinal layer is correlated with postoperative visual acuity [21]. Cheng et al. demostrated that disruption among the ELM or the ellipsoid zone was associated with poor visual outcomes in eyes after the anatomically successful repair of RRDs [22]. Wakabayashi et al demonstrated a disrupted ellipsoid zone in 43% of 51 macula-off eyes and noted that the integrity of both the ELM and the ellipsoid zone was significantly correlated with better visual recovery [7].

In conclusion, SD-OCT is a useful, noninvasive tool for evaluating morphologic changes in the fovea. Several studies investigating foveal microstructural changes by SD-OCT after RRD surgery suggested that ellipsoid zone or ELM disruptions affect postoperative visual outcome. Disrupted ellipsoid zone or ELM could be as a predictor of poor prognosis for visual restoration. Patients with integrity of the ellipsoid zone and ELM were associated with better visual recovery than patients with disruption of the ellipsoid zone or ELM after successful repair of RRD.

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