

Change of subretinal fluid thickness and choroidal thickness after scleral buckling surgery

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巩膜外加压术后视网膜下液厚度与脉络膜厚度的变化

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摘要

目的:观察黄斑区孔源性视网膜脱离巩膜外加压术后视网膜下液厚度与脉络膜厚度的变化。

方法:回顾性非随机临床研究。共23例23眼黄斑区孔源性视网膜脱离患者成功采用巩膜外加压术联合冷冻,排除复发性视网膜脱离和增殖性视网膜前膜患者。采用OCT检测黄斑中心凹下视网膜下液厚度、中心凹下脉络膜厚度。对比观察分析患眼术前,术后1wk,1,3,6,12mo平均最佳矫正视力(BCVA, LogMAR)、黄斑中心凹下视网膜下液厚度、中心凹下脉络膜厚度的变化情况,分析视网膜下液厚度与脉络膜厚度的变化。

结果:术后1wk所有患者均有视网膜下液。术后黄斑中心凹下视网膜下液厚度逐渐下降。术后1wk,中心凹下脉络膜厚度增加,随后中心凹下脉络膜厚度逐渐下降。术后1wk BCVA为 0.60 ± 0.35 ,与术前BCVA比较,差异有统计学意义($t=6.35, P<0.01$)。

结论:视网膜下液随时间逐渐吸收,脉络膜厚度早期增厚后期逐渐下降。视网膜脱离巩膜外加压术治疗累及黄斑区孔源性视网膜脱离,早期提高患者的视力。

关键词:孔源性视网膜脱离;黄斑中心凹下视网膜下液厚度;中心凹下脉络膜厚度;视网膜脱离巩膜外加压术

Abstract

• **AIM:** To investigate subfoveal subretinal fluid thickness (SFT) and subfoveal choroidal thickness (CT) after

scleral buckling surgery (SBS) for macula-off rhegmatogenous retinal detachment (RRD).

• **METHODS:** Retrospective observational case series. Twenty-three patients with macula-off RRD underwent successful SBS combined with cryotherapy. Patients with recurrent retinal detachment and proliferative preretinal membranes were excluded. Optical coherence tomography (OCT) was used to measure subfoveal SFT and subfoveal CT. The OCT images were then evaluated preoperatively and postoperatively at 1wk, 1, 3, 6, and 12mo. Best-corrected visual acuity (BCVA) was measured preoperatively and postoperatively.

• **RESULTS:** All of the patients had subretinal fluid 1wk after operation. Subfoveal SFT gradually reduced over time. The subfoveal CT was thicker 1wk postoperatively and gradually decreased subsequently. The BCVA (mean \pm SD, LogMAR) was 0.60 ± 0.35 , which was a statistically significant change from the preoperative BCVA ($t=6.35, P<0.01$).

• **CONCLUSION:** The subretinal fluid was gradually absorbed with time, and the subfoveal CT gradually decreased after the early thickening. The SBS rapidly improved the visual acuity of the patients after the early postoperative period.

• **KEYWORDS:** rhegmatogenous retinal detachment; subfoveal subretinal fluid thickness; subfoveal choroidal thickness; sclera buckling surgery

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INTRODUCTION

Rhegmatogenous retinal detachment (RRD) is the most common type of retinal detachment. The condition results in significant visual loss, especially when the macula is involved^[1]. RRD requires prompt surgical treatment to reattach the retina. Scleral buckling surgery (SBS) is a common technique for treating retinal detachments. However, persistent subretinal fluid (PSF) after the procedure is very common. The incidence of subretinal fluid (SRF) is 17.6%-94%^[2-7].

The reasons are not fully understood. Kaga *et al*^[8] suggested that the combination of cryopexy and buckling leads to a breakdown of the blood retinal barrier, and this allows excessive amounts of protein to enter the subretinal fluid. Kang *et al*^[9] proposed that choroidal vascular damage caused

by cryotherapy is the main mechanism underlying SRF bleb occurrence. Veckeneer *et al*^[10] suggested that PSF after successful RRD repair could be related to fluid composition. The present study proposed that PSF might be correlated with choroidal thickness (CT). Thus, the subfoveal SFT and subfoveal CT were analyzed in a group of patients who underwent SBS with cryotherapy for macula-off RRD.

SUBJECTS AND METHODS

A retrospective clinical observational study was conducted. From January 1, 2017 to January 31, 2018, 23 patients with primary macula-off RRD were successfully treated with SBS combined with cryotherapy at the Central Theater Command General Hospital. The exclusion criteria included the following: the presence of macula-on RRD, failed scleral buckling surgery, previously performed RRD surgery, proliferative epiretinal membrane, refraction above 8 degrees of myopia, influenced retinal reattachment epiretinal membrane combined with tractional retinal detachment, macular pathology (macular hole or age-related macular degeneration), incomplete postoperative OCT follow-up, and history of trauma, intraocular inflammation, glaucoma or retinal vascular occlusive disease, and systemic diseases (*e.g.* diabetes or hypertension).

The research was approved by the Institutional Review Board at the Central Theater Command General Hospital. The study adhered to the tenets of the Declaration of Helsinki. Consent was obtained from all the subjects, who were informed of the nature of their disease and the potential treatment options.

Each patient underwent a thorough ophthalmologic examination, which included best-corrected visual acuity (BCVA) measurement (with the Snellen visual acuity chart), intraocular pressure (IOP) assessment, slit-lamp examination, binocular indirect ophthalmoscopy, and optical coherence tomography (OCT). For the visual acuity analysis, the Snellen visual acuity values were converted to the logarithm of the minimal angle of resolution (LogMAR). Spectral domain OCT imaging (3D OCT-2000; Topcon, Tokyo, Japan) was performed in the enhanced depth imaging (EDI) mode by the same experienced physician. Each session was performed at approximately 10 AM to avoid diurnal variations. The cross-sectional images were obtained through OCT with a 6 mm width centered on the fovea. The subfoveal subretinal fluid thickness (SFT) and subfoveal CT were measured with the manual calipers provided with the software for the proprietary device.

Subfoveal SRF thickness was defined as the vertical distance between the outer surface of the retina and the inner surface of the underlying retinal pigment epithelium (RPE) under the fovea on the central horizontal line scan. The thickness of the subfoveal CT was defined as the vertical distance from the RPE to the inner surface of the scleral membrane under the fovea on the central horizontal line scan. Age, gender, preoperative symptom duration, and the results of the basic elements of a complete ophthalmic examination were recorded for all the patients.

The operation was performed by two doctors (XC and LH) with extensive experience in retinal detachment and embossing under local anesthesia in all patients. Indirect ophthalmoscopy was performed during surgery to examine the retina to identify the localization of any tears, the extent of retinal degeneration, and the most appropriate SRF drainage site. In all the eyes, the drainage of the SRF was performed at the buckling in relation to the highest retina elevation and far enough from the retinal tears and the choroidal site of the vortex veins. All the retinal tears and retinal degeneration were treated with transscleral cryotherapy. The wall of the eye in the area of the retinal tears and retinal degeneration was indented by the suturing of a silicone buckle on the sclera with 5-0 polyester. All the tears in the retina were located above the indentation that had been verified by indirect ophthalmoscopy.

The patients were followed up for at least 12mo. They were examined again at 1wk and 1, 3, 6, and 12mo after surgery. The visual acuity, presence or absence of anatomical reattachment, and OCT were determined at each follow-up visit. The primary endpoint was the postoperative subfoveal SFT and subfoveal CT. The secondary endpoints included the change in BCVA from the preoperative visit to the 12-month postoperative visit and the frequency of reported complications.

Statistical analysis was performed with SPSS Statistics for Windows, Version 17.0 software. The mean±standard deviation was used to determine the preoperative and postoperative subfoveal SFT, subfoveal CT, and BCVA. The variance analysis of the repeated measurement data preoperative and postoperative BCVA. $\alpha = 0.05$. A P -value of < 0.05 was considered significant.

RESULTS

Twenty-three eyes of 23 patients, 14 men and 9 women, comprised this study. The average age of the patients was 26.04 ± 12.84 years. The range was 18–64 years. The mean symptom duration was 2.77 ± 0.13 (range: 0.06–12) mo. The BCVA was 1.70–0.40 LogMAR units (average 0.96 ± 0.41) before surgery. The baseline patient data are presented in Table 1.

Anatomic success was noted for all 23 eyes after one surgical intervention. The mean subfoveal SFT was 579.26 ± 392.77 μm before surgery. In all the eyes, SRF was detected by OCT 1wk after the operation. Complete absorption of the SRF was observed in 2 of the 23 eyes (8.70%) at 1mo, in 4 eyes (17.39%) at 3mo, 9 (39.13%) at 6mo, and 8 (34.78%) at 6–12mo after the operation. The mean preoperative subfoveal CT was 323.57 ± 140.03 μm . The mean subfoveal CT was 415.30 ± 151.49 μm at 1wk postoperatively, and the mean subfoveal CT was 240.89 ± 52.58 μm at 12mo postoperatively (Figure 1).

At 1wk and 1, 3, 6, and 12mo after surgery, the mean BCVA was statistically significantly higher than that before surgery ($F = 9.63$, $P = 0.00$). The 1wk postoperative BCVA (mean±SD) was 0.60 ± 0.35 LogMAR units, which was a statistically

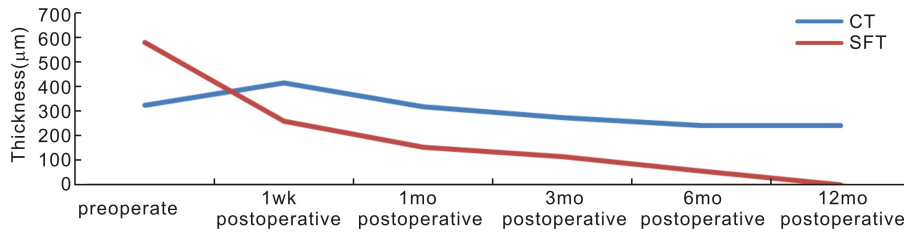


Figure 1 Changes in subfoveal choroid thickness and subfoveal subretinal fluid thickness before and after surgery.

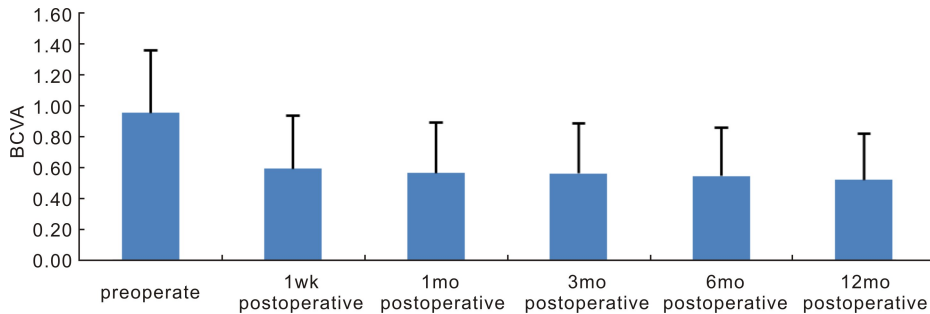


Figure 2 Best-corrected visual acuity before and after surgery.

Table 1 Demographic and baseline characteristics

Parameters	Eyes (<i>n</i> = 23)
Sex (M/F)	14/9
Age, y	26.04±12.84 (18–64)
BCVA (LogMAR)	0.96±0.41 (0.4–1.7)
SFT (μm)	579.26±392.77 (114–1208)
CT (μm)	323.57 ±140.03 (131–737)
Right/Left	11/12
IOP (mmHg)	10.52±1.32 (6–15)
Symptom duration, mo	2.77±0.13 (0.06–12)
Extent of retinal detachment (%)	
1 quadrant	4.35
2 quadrants	86.95
3 quadrants	8.70
4 quadrants	0
Number of retinal holes/tears (%)	
1	47.83
2	39.13
3	13.04
Location of retinal holes/tears (%)	
Superotemporal	34.78
Superonasal	8.70
Inferotemporal	43.48
Inferonasal	13.04

BCVA: Best - corrected visual acuity; SFT: Subretinal fluid thickness; CT: Choroidal thickness; IOP: Intraocular pressure.

significant change from the pre-operation BCVA ($t = 6.35$, $P < 0.01$). At 12mo after surgery, the BCVA (mean±SD) was 0.52 ± 0.30 LogMAR units, which was a significant improvement over the pre-operation BCVA ($t = 7.27$, $P = 0.00$; Figure 2).

During the follow-up period, there was no choroidal hemorrhage, retinal incarceration, retinal perforation, subretinal hemorrhage, or strabismus. During the 1-year follow-up, no recurrence of retinal detachment was observed in any of the affected eyes.

DISCUSSION

In the past, shallow subretinal fluid is quite difficult to detect using regular clinical ophthalmoscopy examination. However, OCT can detect subclinical levels of SRF. Delayed absorption of SRF in scleral buckling is very frequent^[11–13], and persistent SRF often lasts a long time before the fluid is reabsorbed^[14]. In our study, we found that the SRF was detected in all the patients by OCT 1wk after the operation. Eight of the 23 eyes exhibited complete absorption of the subretinal fluid at 6–12mo after operation.

It has been suggested that this delayed absorption is related to the components of subretinal fluid. According to the detachment duration, the total protein concentration in the subretinal fluid increases with time^[15]. Wu *et al*^[14] asserted that after the water is largely reabsorbed after SBS, the residual SRF has a higher concentration of hyaluronic acid, protein, and other components that make reabsorption through the outer blood-retinal barrier more difficult. Moreover, the trauma induced by SBS could further increase the protein concentration of SRF and prevent the SRF from being reabsorbed efficiently. Theodossiadis *et al*^[16] reached a similar conclusion. They argued that surgical trauma to the RPE-Bruch membrane complex could contribute to the accumulation of SRF.

Kang *et al*^[9] reported that indocyanine green angiography revealed choroidal vascular congestion and hyperpermeability near the area with SRF. It has been suggested that SRF accumulation may be associated with choroidal leakage following cryotherapy. The SRF may be related to the viscosity of the subretinal fluid. The high viscosity of the SRF would slow fluid absorption. The incidence of persistent SRF by SBS is more than that of pars plana vitrectomy (PPV)^[17–18]. The present study hypothesized that it was related to the choroidal thickness. The present study found that the choroid membrane thickened after 1wk. Akkoyun *et al*^[19] reported similar results; a thicker CT 1wk after SBS.

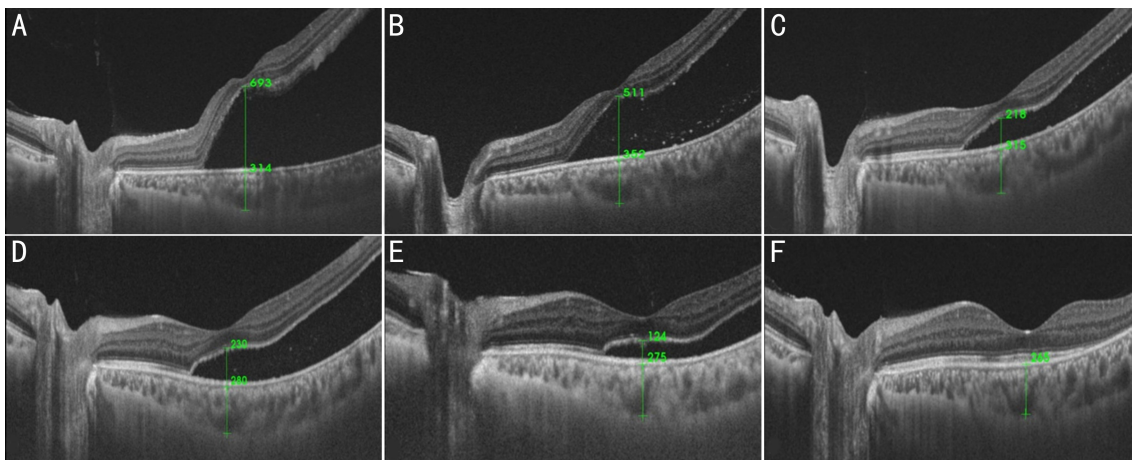


Figure 3 Preoperative and postoperative horizontal optical coherence tomography (OCT) images of the left eye of a 23-year-old man with rhegmatogenous retinal detachment A: Preoperative OCT: the subfoveal subretinal fluid thickness (SFT) was 693 μm, and the subfoveal choroidal thickness (CT) was 314 μm; B: The 1-week postoperative OCT: the subfoveal SFT was 511 μm, and the subfoveal CT was 352 μm; C: The 1-month postoperative OCT: the subfoveal SFT was 243 μm, and the subfoveal CT was 309 μm; D: The 3mo postoperative OCT: the subfoveal SFT was 230 μm, and the subfoveal CT was 280 μm; E: The 6mo postoperative OCT: the subfoveal SFT was 124 μm, and the subfoveal CT was 275 μm; F: The 12mo postoperative OCT: the subfoveal CT was 265 μm.

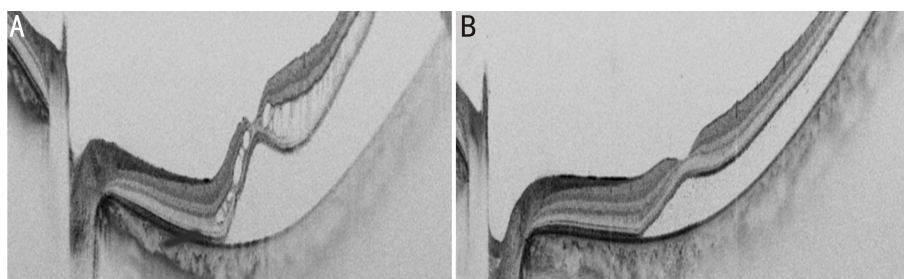


Figure 4 Preoperative and postoperative horizontal optical coherence tomography (OCT) images of the left eye of a 21-year-old man with rhegmatogenous retinal detachment (RRD) A: Preoperative horizontal OCT images showed extensive edema in the fovea outer nuclear layer. He had a preoperative Snellen best-corrected visual acuity (BCVA) of 20/200; B: One week after successful scleral buckling surgery, the extensive edema with cystoid spaces in the macula had disappeared. His Snellen BCVA improved to 20/40.

The present study postulated that scleral buckling directly imposed on the sclera near the quadrant of the retinal break, obstruction of the vortex veins reflux^[20], reduces choroidal blood flow^[21], choroidal blood pressure elevate, choroidal vascular congestion and choroidal vascular hyperpermeability^[9], and an increase in the subfoveal choroidal thickness^[22]. Iwase *et al*^[23] also concluded that scleral buckling surgery could reduce the choroidal blood flow and increase the subfoveal CT. Miura *et al*^[24] found that the CT temporarily increased but returned to normal 4wk after surgery. Kimura *et al*^[22] found that the subfoveal CT returned to normal 3mo after surgery.

The subfoveal CT could also be aggravated by intraoperative cryotherapy and postoperative choroidal inflammation. After retinal detachment repair, Kashani *et al*^[25] found a decrease in subretinal fluid height; however, there was a decrease in the optical density ratios during the absorption of SRF. The osmotic pressure of the fluid remnants would be increased in relation to the increase in protein concentration in subretinal fluid. The increase in osmotic pressure reverses that the flow physiologically runs from the choriocapillary fluid to SRF. The condition and thickness of the choroidal vasculature reaches a new equilibrium that can create and maintain the SRF, and the SRF is dynamic.

The present study suggests that SRF is mainly come from choroidal vascular, it contains a high concentration of oxygen and nutrients that allow for the long-term survival of the outer layer of the retina. With the adaptation of the pressure forces and the decrease in choroidal inflammation, the thickness of the choroid membrane gradually decreases after the early thickening, and the SRF is gradually absorbed over time. The hydrostatic pressure changes caused by SRF absorption, RPE, and photoreceptor reattachment would therefore be in balance^[26].

SRF is believed to induce damage to the outer segment of the photoreceptor by blocking the diffusion of oxygen and nutrients^[27]. However, the present study found that the patients' visual function had recovered rapidly at 1wk after surgery. The average BCVA was significantly improved to 0.60 LogMAR units. Thus, it is likely that the SRF comes mainly from the choroid circulating liquid. In addition, the SRF contains nutrients composition. The preoperative SRF comes mainly from the anterior chamber fluid and vitreous fluid, and the outer retinal cells deteriorate from the reduction of nutrients and oxygen. Thus, the preoperative SRF nutritional composition is different from the postoperative SRF. In addition, the preoperative OCT indicates that the extensive edema in the outer nuclear layer significantly affected retinal

function.

One week after successful SBS, the widespread retinal edema with cystoid spaces in the macula had disappeared. Even if there was SRF separating the retinal photoreceptor outer segment from the RPE, the outer layer of the retina could perform metabolism; thus, visual acuity was significantly improved. This confirmed that the subretinal fluid was from choroidal vascular.

Although the delayed absorption of subretinal fluid has been associated with a worse visual outcome^[28], the association between persistent subfoveal fluid and a worse visual prognosis was negligible^[7]. Other studies have found that the presence and extent of persistent SRF after successful scleral buckle surgery had no effect on final visual acuity or anatomic attachment^[29]. At 1y after surgery, the mean BCVA was only 0.52 LogMAR units. This indicated that the normal oxygen and nutrients had diffused from the retinal pigment epithelium to the photoreceptors even if SRF was present.

This study was limited by its retrospective design, thus, there is the possibility of patient selection bias. The number of cases was insufficient. Because of the small sample size, the statistical power might have been relatively low. In addition, the manual measurement of the subfoveal SFT and subfoveal CT could have introduced errors. The last 6-month interval between the OCT examinations might have been too long to enable the detection of any detailed dynamic changes in the SRF. The thickness of the subfoveal SRF and subfoveal CT was measured on the central horizontal single line scan. Thus, the findings of this study need to be verified by large samples, multiple centers, and long-term follow-up results.

The findings revealed that after SBS for macula-off RRD, the SRF was gradually absorbed over time, and the subfoveal CT gradually decreased after the early thickening. The SBS rapidly improved visual acuity after the early postoperative period. Further studies are needed to investigate these factors.

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2020 中国科技核心期刊眼科学类期刊主要指标及排名

期刊名称	核心总被引频次		核心影响因子		综合评价总分	
	数值	排名	数值	排名	数值	排名
中华眼科杂志	1909	2	0.963	1	73.2	1
眼科新进展	1430	3	0.842	2	66.0	2
国际眼科杂志	2133	1	0.589	5	54.9	3
中华眼科医学杂志电子版	114	10	0.455	8	48.3	4
中华实验眼科杂志	1056	4	0.677	3	43.1	5
中华眼底病杂志	738	5	0.585	6	37.9	6
临床眼科杂志	450	7	0.470	7	37.6	7
眼科	388	8	0.393	9	26.9	8
中华眼视光学与视觉科学杂志	661	6	0.590	4	21.8	9
中国斜视与小儿眼科杂志	240	9	0.376	10	13.6	10

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