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Long-Term Postoperative Perfusion Status in Giant Retinal Tears: A Preliminary Case Report

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Abstract

Background: Information on the long-term perfusion status of patients after successful surgery for giant retinal tear (GRT) macula-off rhegmatogenous retinal detachment (RRD) is limited. Purpose: To examine long-term structural, functional, and perfusion outcomes in normal control eyes and eyes treated for different degrees of GRT-associated extensions of RRD. **Methods:** One emmetropic normal eye (control), one healthy highly myopic eye (control myopic), and three eyes surgically treated for GRT (surgical), were included in the study for a long-term comparison of study outcomes. The surgical eyes were classified based on the degree of GRT-associated RRD extension as follows: one eye with GRT-associated RRD extension < 180˚; one eye with GRT-associated RRD extension between 180˚ - 270˚; and one eye with GRT-associated RRD extension > 270˚. Structural, functional, and perfusion outcomes were compared with those of the control eyes. **Results:** All three eyes were phakic and the condition was monocular. The mean age of the patients was 48.67 ± 8.50 years (range, 39 - 55 years). All three eyes had GRT macula-off RRD. The mean preoperative time for GRT surgery was 1.2 weeks. The mean pre- and postoperative best corrected visual acuities (BCVA) were 1.87 logMAR and 0.46 logMAR, respectively. The mean postoperative follow-up period was 19.67 ± 5.69 months. Proliferative vitreoretinopathy resulted in multiple surgeries in one eye (31.5%). Long-term postoperative optical coherence tomography (OCT) showed abnormal retinal thickness, ellipsoid zone disruption, and external limiting membrane line discontinuities in one eye. OCT angiography yielded abnormal perfusion indices in the surgically treated eyes. **Conclusions:** Our data showed multiple structural alterations in spectral-domain OCT biomarkers. One eye that developed secondary epiretinal membrane (ERM) proliferation showed a significantly improved BCVA after proliferation and internal limiting membrane were removed. Perfusion findings were correlated with the final BCVA. Despite a fully reattached retina without ERM proliferation, GRT-associated RRD has a guarded functional prognosis.

Keywords

Choriocapillaris Subfoveal Plexus, Deep Vascular Plexus, Giant Retinal Tears, Macular Perfusion Indices, Rhegmatogenous Retinal Detachment

1. Introduction

Rhegmatogenous retinal detachment (RRD) associated with giant retinal tears (GRTs) is an uncommon condition with a guarded prognosis, as it may cause significant visual morbidity from retinal detachment [1]. GRT-associated RRD is a tractional event, an acute condition, that is complicated by the vitreoretinal interface in which pathological contraction phenomena of the vitreous and the bed of a normal or predisposed retina cause a full-thickness circumferential retinal tear of >90˚ associated with vitreous detachment [2] [3]. The high incidence of proliferative vitreoretinopathy (PVR) from GRT is due to the release and fibrous metaplasia of a high number of retinal pigment epithelial cells (RPE cell dispersion), inflammatory breakdown of the retina-blood barrier, and upregulated release of multiple pro-inflammatory factors and cytokines resulting in a rapid occurrence of PVR [1]. The annual incidence of GRT is not clearly established in the literature; however, it is estimated that between 0.05% to 0.09% per 100,000 people every year experience the condition [2]-[7]. GRT predominantly affects male sex, with up to 72% of the total patients being male [2]-[7], representing 1.5% of the total RRDs, with an average age of 42 years at diagnosis [3] [6].

The formation of GRT is attributed to the combination of an area of retinal abnormality and dynamic vitreous traction [3]. This type of retinal tear occurs acutely in different magnitudes. The severity is known to depend on the substrate and condition of the eye [8]. The coalition of multiple horseshoe tears on the posterior border of the vitreous base due to acute pathologic contraction of the vitreous may also be associated with the formation of GRTs. These pathologic conditions lead to a circumferential rupture of the retina greater than one peripheral quadrant (>90˚ retina rupture).

Several risk factors may be the causation for these pathologic changes, which include, local factors, systemic risk factors, and some other unknown or secondary conditions [2] [3] [8] [9] [10]. A large epidemiologic study conducted in the United Kingdom (2010) has found that approximately 55% GRTs are idiopathic. Other studies have found an association between GRTs and several other ocular and systemic conditions: 25% are myopia-associated, 14% are associated with hereditary conditions related to defects in type 2 collagen synthesis, such as Marfan's, Stickler-Wagner, and Ehrler Danlos syndromes, and 12.3% results from eye blunt trauma [2] [3] [8] [9] [10]. Other risk factors include high myopia, aphakia, and pseudophakia [2] [3] [8] [9] [10]. Moreover, other more rare conditions that have been found to be associated with GRT include aniridia, lens coloboma, microspherophakia, retinitis pigmentosa, and endogenous endophthalmitis [11].

In GRTs, the rate of anatomic success after the first surgery is between 80% and 90%, whereas the final reattachment rate is 94% - 100% [12] [13]. However, the condition is very difficult to manage owing to the risks of several intra and postoperative complications. Additionally, several histopathological abnormalities may occur during surgical procedures, e.g., during scleral buckling surgery (e.g., placement of scleral buckle (SB), encircling bands, compression of the eyeball, and cryotherapy to the scleral vessels) may result in an interruption of the blood supply to the anterior segment of the eye [14] [15] [16] [17].

The aim of this study was to evaluate the long term postoperative retinal and choroidal vasculature in eyes with GRT-associated macula-off RRD and eyes undergoing vitrectomy without complementary scleral buckling using optical coherence tomography (OCT) angiography. This will help to improve the control-perfusion vitrectomy techniques without the probable deleterious effects of scleral buckling on the retinal and choroidal perfusion. We compared the indices of macular microcirculation in normal emmetropic (**Figures 1(a)-(k)**), normal healthy myopic (**Figures 1(l)-(w)**), and operated eyes with GRT macula-off RRD that resolved completely after vitrectomy surgery and minimized the confounding variables.

2. Patients and Methods

2.1. Study Design

This study adhered to the tenets of the Declaration of Helsinki and was approved by the ethics and teaching committees of the enrolled institution. Written informed consent was obtained from all patients in accordance with institutional guidelines.

The three patients who were included in the surgical cohort fulfilled the following criteria: age ≥ 18 years, having GRT-associated macula-off RRD, evidence of PVR grade B or less, retinal attachment at the last follow-up examination visit, absence of intraocular silicone oil in the last follow-up visit, at least 6 months of follow-up, and a well-documented long-term structural, functional, and perfusion findings evaluation of the macula during follow-up visits [18].

Patients who fulfilled any of the following criteria were excluded from the study: any prior complicated surgeries (e.g., vitreoretinal surgery or intravitreal injections), GRT-associated RRD (e.g., due to open eye injuries), and GRT-associated RRD with a macular hole retinal detachment caused by myopic traction maculopathy (MTM). Other exclusion criteria included the presence of intraocular silicone oil during the final evaluation, PVR (posterior or anterior) with recurrent RRD, and presence of active glaucoma. Additionally, patients who could not maintain the follow-up procedures and those who were operated on in a different institution

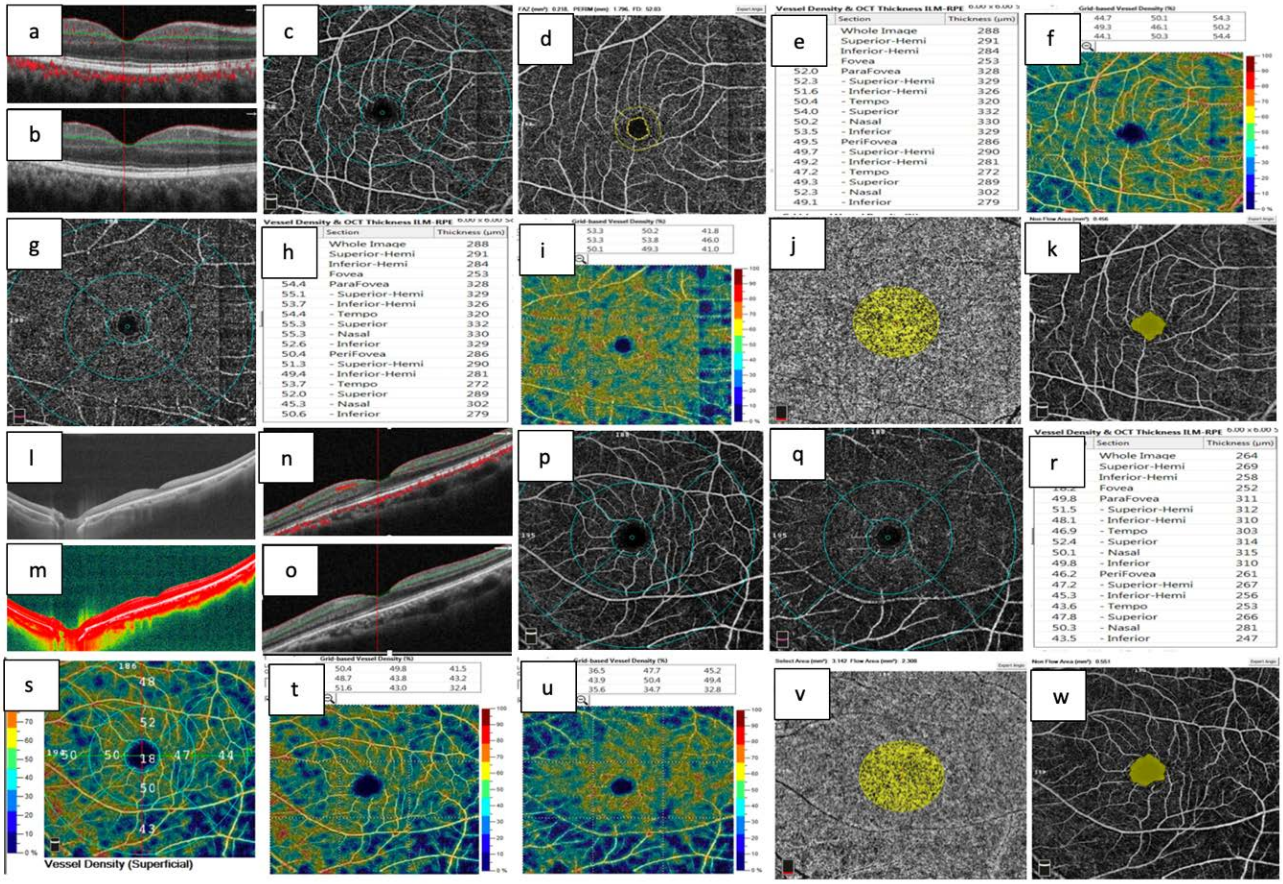

Figure 1. Control normal eyes. (a) Horizontal b scan of a normal emmetropic eye automated with red and green segmentation lines; the red dots indicate choriocapillaris flow. (b) Horizontal b scan with red and green segmentation lines. (c) Normal superficial vascular plexus (SVP) slab with an ETDRS (early treatment diabetic retinopathy study)-like sector grid overlay. (d) SVP slab with a normal outlined foveal avascular zone (FAZ). (e) Superficial perfusion indices and retinal thickness at different macular subregions. (f) The color overlays on the OCT angiography image indicate a normal vessel density value in the key to the right, and normal superficial vessel density (VD) perfusion indices are depicted above the image. (g) Normal deep vascular plexus (DVP). (h) Deep perfusion indices are located at different macular subregions. (i) The color overlays on the OCT angiography indicate a normal VD value in the key to the right, and normal deep VD perfusion indices are depicted above the image. (j) The image shows a normal choriocapillaris flow area. (k) Normal FAZ area of 0.456 mm^2. (l) High definition (HD) 12-mm horizontal b scan of a normal myopic eye. (m) HD 12-mm horizontal b scan in a brighter color. (n) Horizontal b scan with green and red segmentation lines, with red dots corresponding to the retina and choroidal vessels. (o) Normal horizontal b scan with segmentation lines in a healthy myopic eye. (p) A corresponding SVP slab. (q) Normal DVP slab in a myopic eye. (r) Normal perfusion indices with corresponding retinal thickness values at the different macula subregions. (s) VD at SVP in a normal myopic eye, the color overlays on the OCT angiography image indicate a normal vessel density value in the key to the left. (t) and (u) Images of the corresponding superficial and deep perfusion indices with different normal values as indicated above the images. (v) The image depicts a normal choriocapillaris flow of 2.308 mm^2 at the selected subfoveal choriocapillaris area of 3.142 mm^2. (w) The image shows a normal regular FAZ area of 0.561 mm^2.

or with severe complications (e.g., endophthalmitis, recurrent disease, complicated severe PVR RRD, and refractory corneal opacities) were also excluded [18].

The following assessments were conducted: long-term postoperative structural spectral-domain (SD)-OCT findings, including foveal contour profile, central subfoveal ellipsoid zone (EZ) status, central subfoveal external limiting membrane (ELM) line appearance, en-face imaging or cross-sectional SD-OCT B-scan analysis for the presence of dissociated optic nerve fiber layer (DONFL) defects, and the presence of epiretinal membrane (ERM) proliferation over the macula. Postoperative macular perfusion evaluation included vessel density (VD) at the superficial vascular plexus (SVP), deep vascular plexus (DVP), foveal avascular zone (FAZ), and choriocapillaris subfoveal plexus (CSP). The BCVA in Snellen unit was converted to logMAR units using standard formulas.

The clinical charts of the included patients, with a diagnosis of GRT-associated with RRD and treated between May 2017 and January 2021, were included and interpreted. Only eyes with a fully attached retina and functional vision on the patients' last postoperative evaluation, regardless of the number of surgical procedures needed, were selectively included. Thus, three selected eyes from three patients were classified according to the circumferential size of the GRT. One eye had RRD associated with circumferential retinal tears of <180˚, one eye had RRD associated with circumferential retinal tears between 180˚ and 270˚, and one eye had RRD associated with circumferential GRTs of >270˚. The postoperative eyes were analyzed statistically to demonstrate the postoperative functional, structural, and perfusion macula-off retinal detachment outcomes. Only eyes in which the retina was successfully reattached without the presence of intraocular silicon for a minimum of 6 months of follow-up after the last vitreoretinal surgical procedure were included in the general dataset.

2.2. Examinations

All the patients underwent a detailed eye examination, which included preoperative evaluations such as visual acuity, slit-lamp examination, fundoscopy, and indirect ophthalmoscopy. The assessment protocols used in these cases have been reported previously [18]. In brief, cross-sectional images of the macular region were acquired along the horizontal plane through the foveal center using Spectralis OCT (Heidelberg Engineering, Heidelberg, Germany), or, in some cases, SD-OCT (RTVue-XR platform SD-OCT, Optovue Inc., Fremont, CA, USA), and the axial lengths were measured using partial coherence laser interferometry (Zeiss IOL Master 700; Carl Zeiss Meditec AG, Oberkochen, Germany). GRT-associated with RRD was diagnosed through indirect ophthalmoscopy and B-scan ultrasonography (A and B Ultrasound Unit, Quantel Medical, Du Bois Loli, Auvergne, France). The postoperative microstructural evaluation was performed using SD-OCT Spectralis OCT and RTVue-XR platform SD-OCT. The following postoperative structural and perfusion assessments of the eyes were statistically analyzed in three groups: long-term postoperative structural SD-OCT findings, including central subfoveal thickness (CSFT), foveal contour profile, central subfoveal EZ status, central subfoveal ELM line appearance, en-face imaging or cross-sectional SD-OCT B-scan analysis for the presence of DONFL defects, and the presence of ERM proliferation over the macula.

Postoperative perfusion and quantitative VD and choroidal flow evaluations were completed using an OCT angiography device (RTVue XR OCT Avanti with

AngioVue Software; OptoVue Inc., Fremont, CA, USA). More details about the equipment can be found elsewhere [19]. Default retinal imaging settings and built-in projection artifact removal tools were used to perform image adjustment and segmentation. Segmentation of the SVP, DVP, outer retinal layer, and CSP slabs was performed using the AngioVue software. The imaging data were interpreted by an independent analyst. The scan quality was evaluated using the standard signal strength index (SSI) provided by the software, and only scans with an SSI > 46 were included.

The procedure for image analysis was done following a published protocol [19]. In brief, the FAZ area in the SVP slab was quantitatively evaluated by analyzing images in the AngioVue system. A built-in tool in the AngioVue system was used to measure the VD [20] [21]. All multimodal evaluations and images were analyzed by three experienced retina specialists (co-authors) from the participating institution.

2.3. Surgical Technique

The surgical technique performed in these patients was described in detail previously [18]. In brief, standard 25-gauge 3-port pars plana vitrectomy (Alcon Constellation Vision System, Alcon Labs, Fort Worth, TX, USA) was performed using a contact wide-angle viewing precorneal lens system (ROLS reinverted system Volk Medilex, Miami, FL, USA) or the Wide-Angle Viewing System with the resight non-contact lens (Carl Zeiss Meditec AG, Jena Germany). In addition to central vitrectomy, we used diluted triamcinolone acetonide adjuvant (Kenalog 40 mg/mL; Bristol-Myers Squibb, New York, NY, USA) to better visualize the vitreous face, vitreous base, and its posterior border, and performed the removal of the cortical face from the surface of the retina using a silicone-tipped cannula with active suction prior to perfluorocarbon liquid infusion and reattachment of the retina. A subretinal fluid endodrainage was performed as described previously [18]. In brief, endodrainage was done slowly by implementing a first-step air-to-fluid exchange over the edge of the GRT to avoid posterior retinal slippage before proceeding to a second air-fluid exchange and continuing with subretinal fluid drainage. Once the retina was completely reattached, continuous argon laser endophotocoagulation was performed. Finally, as the last surgical step, a non-expandable bubble containing 15% perfluoropropane (C_3F_8) gas mixture was used as a long-acting tamponade at the end of the procedure in the three cases, as previously described [18].

2.4. Statistical Analysis

Data were entered and processed using Microsoft Excel and analyzed using GraphPad Prism version 8.2.1 and SPSS for Windows version 28. Data were assessed for normal distribution, and appropriate statistical tests were selected. Spearman's correlation test was used to test the relationship between perfusion indices and final visual outcome. The Wilcoxon matched signed-rank test was used to compare the preoperative and postoperative BCVA values in the surgical group (logMAR). For functional evaluations among the stages and surgical variants, only the final postoperative BCVA was included in the statistical analysis. Statistical significance was set at $p < 0.05$.

Eyes were divided into three groups according to tear magnitude: patients with a GRT < 180˚, those with a GRT of 180˚ - 270˚, and those with a GRT > 270˚. The Kaplan–Meier method was used to evaluate the general survival for final postoperative BCVA logMAR units between the eye groups.

3. Results

The clinical charts of three consecutively selected patients who were surgically managed between January 2015 and May 2021 were analyzed. Only eyes with a fully attached retina and functional vision on the patients' last postoperative evaluation were selectively included, regardless of the number of surgical procedures needed. Thus, three eyes from three patients were included and classified according to the circumferential size of the GRT. The postoperative eyes were analyzed statistically to demonstrate the functional, structural, and perfusion macula-off retinal detachment outcomes. Only eyes in which the retina was successfully reattached without the presence of intraocular silicon for a minimum of 6 months of follow-up after the last vitreoretinal surgical procedure were included in the general dataset.

3.1. Outcome Measures

Macular quantitative perfusion indices (superficial and deep vessel density at different subdivided sections of the macula), structural outcomes and functional improvements were compared in terms of logarithm of the minimum angle of resolution (logMAR) units. Anatomical success was defined by the disappearance of the RRD without new retinal tears, clinically and tomographic resolution of the macular subretinal fluid, or reattachment of the retina before the final visit regardless of the number of surgical procedures. The SD-OCT findings at the last follow-up evaluation were used to perform statistical microstructural comparisons; the long-term OCT angiography perfusion indices were assessed in the last visit. Data were collected by two other macula and retina specialists masked to other information, and a third observer evaluated the SD-OCT readings in case of disagreements.

3.2. General Outcomes

No evidence of PVR or other postoperative complications was found in the eye with GRT-associated RRD extension < 180˚. The postoperative BCVA (0.48 logMAR) was significantly better than the preoperative BCVA (2.00 logMAR) (**Table 1**). In the eye with GRT-associated RRD extension = 180˚ - 270˚, the pre- and post-operative BCVA values were 1.60 logMAR and 0.30 logMAR, respectively. In the eye with GRT-associated RRD extension > 270˚, the pre- and post-

Table 1. Patients' demographic data and pre-operative clinical characteristics.

Study groups	Age (y)	Preoperative BCVA (logMAR units)	Axial length (mm)	Post-operative follow-up months
Control emmetropic eye (n = 1)	54	0.00	20.32	-
Control myopic eye (n = 1)	62	0.00	29.12	-
Surgical group (n = 3)				
GRT < 180˚	55	2.00	22.54	18
GRT 180˚ - 270˚	52	1.60	26.38	26
GRT > 270˚	39	2.00	30.10	15

BCVA, best-corrected visual acuity; GRT: giant retinal tear.

operative BCVA values were 2.00 logMAR, and 0.60 logMAR, respectively (Table 1).

3.3. Structural Analysis among Eyes

To describe the structural postoperative SD-OCT findings (Table 2), we used the terminology proposed in the International Nomenclature for Optical Coherence Tomography Panel report, [22] which correlated with the functional findings. The statistical program yielded the following SD-OCT findings: foveal contour (33.3% of the eyes), EZ disruption (33.3%), DONFL abnormalities (33.3%), and ELM line alterations (33.3%). The differences between these categorical variables were not statistically significant ($p > 0.05\%$) (Table 2).

3.4. Perfusion Analysis among Eyes

The superficial FAZ area in the control emmetropic eye was significantly smaller than that in the other eyes. The superficial foveal VD in the emmetropic eye differed only from that of the eye with GRT-associated RRD extension between 180˚ and 270˚ and >270˚. Deep foveal VD differed only between the emmetropic eye and the eye with GRT-associated RRD extension of >270˚. The flow area in the CSP was significantly larger in the emmetropic group.

Decreased superficial foveal VD correlated with poor visual outcome in eyes with GRT-associated RRD extension > 270˚. Similarly, a smaller flow area in the CSP was associated with poorer visual outcomes in eyes with GRT-associated RRD extension > 270˚ (Table 3).

A Kaplan-Meier survival probability plot was used to visualize tear magnitude. Each plot represents the survival probability of different groups over time (Figure 2).

3.5. Surgical Cases

Surgical case 1

Table 2. Comparison between tear magnitude groups: associations with study variables.

	Sample	Tear < 180˚	Tear 180˚ - 270˚	Tear > 270˚
	N = 3	*N* = 1	*N* = 1	*N* = 1
Foveal contour				
Normal	2 (66.6%)	1	1	
Abnormal	1 (33.3%)			1
Ellipsoid zone				
Normal	2 (66.6%)	1	1	
Disrupted	1 (33.3%)			1
DONFL defects				
Absent	2 (66.6%)	1	1	
Present	1 (33.3%)			1
ELM line				
Normal	2 (66.6%)	1	1	
Disrupted	1 (33.3%)			1

DONFL, dissociated optic nerve fiber layer; ELM, external limiting membrane.

Table 3. Comparative functional, structural and quantitative evaluation of macular perfusion indices of th study eyes.

Study groups	Superficial FAZ area (mm^2)	Superficial foveal VD (%)	Deep foveal VD (%)	Superficial parafoveal VD (%)	Deep parafoveal VD (%)	Superficial whole macula VD (%)	Deep whole macula VD (%)	Flow area (mm^2) at the choriocapillaris subfoveal plexus	CSFT (μm)	Postoperative BCVA
Emmetropic controls	0.31	32.17	32.29	57.72	58.27	57.83	57.40	2.54	242.40	0.00
High myopia controls	0.53	31.77	33.21	56.34	55.88	47.45	49.45	2.45	254.3	0.00
Surgically treated (n = 3)										
GRT < 180˚	0.89	27.93	30.22	47.69	49.23	49.13	49.35	1.95	206.9	0.48
GRT 180˚ - 240˚	1.42	20.07	24.40	35.21	37.22	39.22	40.26	1.24	190.0	0.30
GRT < 270˚	1.83	21.54	22.68	25.72	28.91	30.11	32.39	1.36	204.8	0.60

*Indicates where data differed significantly ($p < 0.05$) from the control emmetropic eye. The BCVA in the control emmetropic and control high myopia eyes was used for comparison with postoperative BCVA in the surgical group. BCVA: best corrected visual acuity; FAZ: foveal avascular zone; VD: vessel density; CSFT: central subfoveal thickness.

A 55-year-old phakic, symptomatic woman presented with complaints of metamorphopsia and sudden visual loss in her right eye. The vision loss occurred over a period of 7 days. The preoperative visual acuity of the right eye was 20/2000 (logMAR 02.00), with a refractive error of −2.00 + 1.25 × 10, an axial length of 22.54 mm, and an ocular tension by applanation tonometry of 10 mmHg. The evaluation of the fundus showed a total detachment of retina due to a giant tear of the meridian from VIII meridian to I meridian, with clear media,

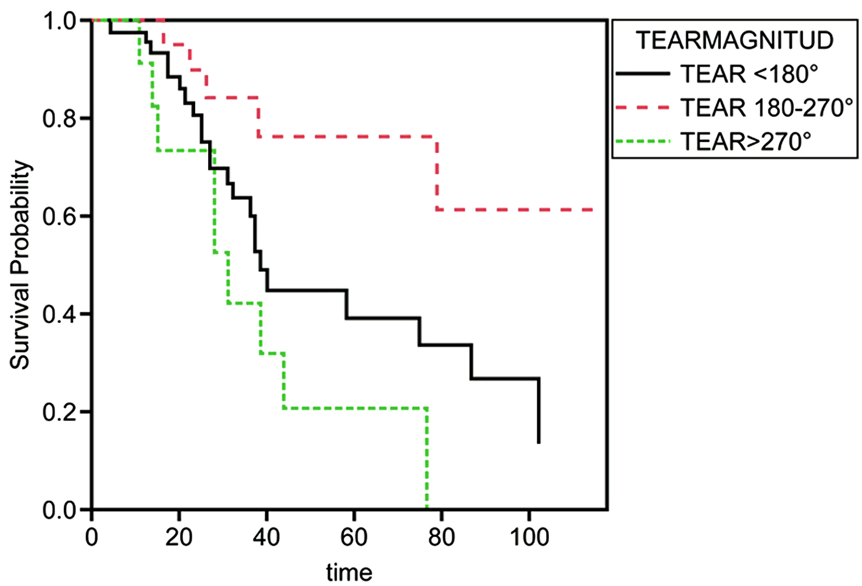

Figure 2. Kaplan-Meier survival plots. Kaplan-Meier survival probability plot tear magnitude. Each curve represents the survival probabilities of a different group over time.

vitreous liquefaction, and a large amount of pigment granules. The tear bent on itself showing a large amount of subretinal fluid beneath the macula (**Figure 3(a)**). Multiple areas of thinning were detected in the retina with some liquid sockets and areas of vitreoretinal traction. The patient underwent uneventful gas-vitrectomy, no scleral cerclage was installed, and with 15% C_3F_8 gas injection, the evolution was satisfactory, as the retina remained attached and visual acuity showed a satisfactory recovery. At the 18-month follow-up, the final BCVA was 20/60 (logMAR 0.48). Several SD-OCT biomarkers were noted, such as an irregular foveal contour and internal and external neuroretina lines without total restoration of the central subfoveal ellipsoid, including at the EZ and the ELM line (**Figure 3(b)**). The long-term postoperative perfusion evaluation was abnormal, with lower-than-normal perfusion indices on the SVP (**Figure 3(c)**) and DVP slabs (**Figure 3(d)**). The perfusion indices were quantified and found to be lower than normal (**Figures 3(e)-(h)**). The choriocapillaris flow area was considered to be within 2.113 mm^2 (**Figure 3(i)**) with an enlarged and irregular FAZ area of 4.036 mm^2 (**Figure 3(j)**)

Surgical case 2

A 52-year-old phakic, symptomatic woman presented with concerns of aggravating metamorphopsia and entopic phenomena; these were accompanied by a progressive and rapid drop in central vision and high myopia. The right eye had an axial length of 26.38 mm and a GRT macula-off associated RRD of 200˚ extension over the temporal and superior quadrants (**Figure 4(a)**) underwent an uneventful gas-vitrectomy surgery (**Figure 4(a)**). The preoperative BCVA was measured at 20/800 (logMAR 1.60). We performed a three-port 25-G pars plana vitrectomy and perfluorocarbon liquid assisted technique to flatten the retina and perform endodrainage of subretinal fluid. Fluid-air gas exchange was performed

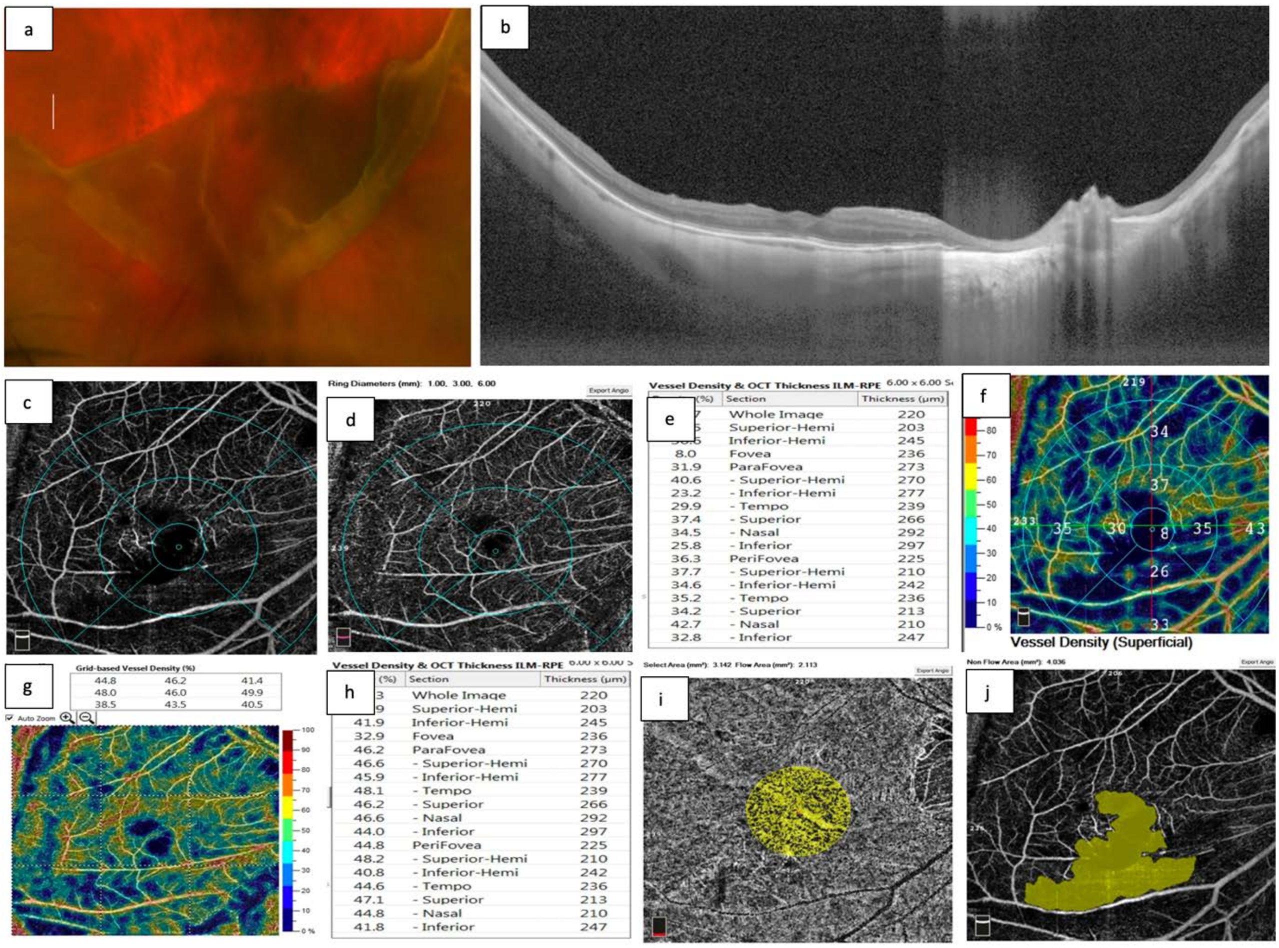

Figure 3. Surgical case 1. (a) Image of the fundus of a 55-year-old phakic, symptomatic woman presented with complaining of metamorphopsia and sudden visual loss in her right eye. The visual loss occurred over a period of 7 days. The image showed a total retinal detachment due to a giant tear extending from the IX to I meridian meridian (the clinical image shown was adopted from a previous publication (18) from our group). (b) Postoperative HD 12-mm horizontal b scan. Several SD-OCT biomarkers were noted, such as an irregular foveal contour and internal and external neuroretinal lines without total restoration of the central subfoveal ellipsoid zone and the external limiting membrane line. (c) Superficial vascular plexus showing certain vascular deficiencies of the perfusion indices. (d) Deep vascular plexus slab with better perfusion indices. (e) Quantified superficial perfusion indices at different subregions of the macula. (f) The color overlays on the OCT angiography image indicate abnormal superficial VD value in the key to the left with the ETDRS-like sector grid overlay. (g) The color overlays on the OCT angiography image indicate a normal deep VD value in the key to the right. (h) The image depicts deep perfusion indices at different subfields of the macula with the corresponding retinal thickness. (i) Choriocapillaris flow area of 2.113 mm^2 within the selected subfoveal choriocapillaris area of 3.142 mm^2. (k) Enlarged irregular non-flow tissue corresponding to a FAZ area of 4.036 mm^2. ETDRS: early treatment diabetic retinopathy study, OCT: optical coherence tomography, SD: spectral domain, VD: vessel density.

with 15% C_3F_8 tamponade. After a 26-month longitudinal follow-up (**Figure 4(b)**), the operated eye showed a postoperative BCVA of 20/40 (logMAR 0.30). The long-term high-definition 12-mm structural b scan evaluation revealed an irregular foveal profile with well-recognized outer retina biomarkers (**Figure 4(c)** and **Figure 4(d)**). The postoperative perfusion indices at the SVP (**Figure 4(e)** and DVP slabs (**Figure 4(f)**) were found to be below the mean value with no evidence of ERM proliferation. The quantified perfusion indices at the different subregions of the macula along with the retinal thickness were lower than normal

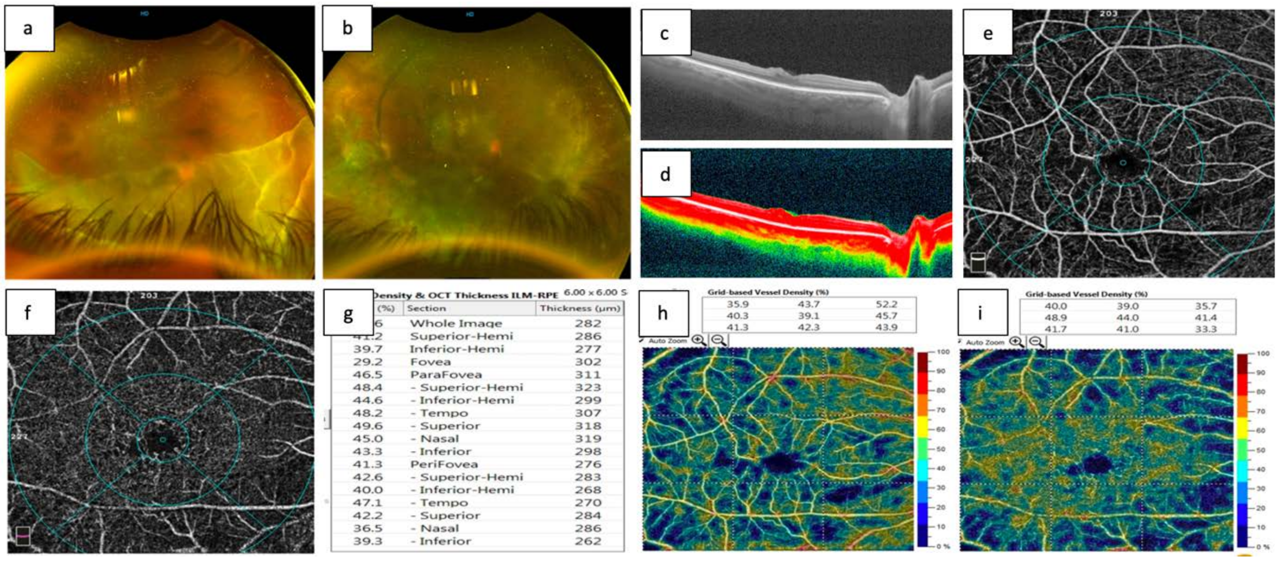

Figure 4. Surgical case 2. (a) The image shows the fundus of a 52-year-old phakic, symptomatic myopic woman who presented with concerns of aggravating metamorphopsia and entopic phenomena, which were accompanied by a progressive and rapid drop in central vision. The right eye with an axial length of 26.38 mm and a macula-off giant retinal tear-related rhegmatogenous retinal detachment of 200˚ extension over the temporal and superior quadrants underwent an uneventful gas-vitrectomy surgery. (b) The image depicts the fundus at the 26-month follow-up; the operated eye showed a postoperative BCVA of 20/40 (logMAR 0.30). (c) and (d) Images depicting a high-definition SD-OCT horizontal b scan with an irregular foveal profile and diffuse retinal thinning; the outer retina biomarkers are identifiable. (e) and (f) Corresponding superficial and deep vascular plexuses slabs. (g) The image shows different values of the perfusion indices and retinal thickness at different subregions of the macula. (h) and (i) Color overlays on an OCT angiography, indicating superficial and deep vessel density values in the key to the right; the quantified perfusion indices in different subregions of the macula are depicted above. BCVA: best corrected visual acuity, OCT: optical coherence tomography, SD: spectral domain.

values (Figure 4(g)). Color overlays on the OCT angiography images indicating superficial (Figure 4(h)) and deep (Figure 4(i)) quantified VD values at the different subregions of the macula seen in the key to the right and above the images were considered lower than normal values.

Surgical case 3

A 39-year-old man with 2 days of sudden decreased vision with metamorphopsia, high myopia, and severe PS. The patient was diagnosed with a familial condition consistent with Stickler's syndrome by the genetic unit. A diagnosis of GRT-associated RRD of more than 270˚ extension was made (Figure 5(a) and Figure 5(b)). The preoperative BCVA was 20/2000 or counting fingers at 2 feet (logMAR 2.00), with PS and an axial length of 30.10 mm. This right phakic eye underwent a 25-G three-port pars plana gas-vitrectomy. Because of recurrent and a complicated proliferative vitreoretinopathy (PVR) RRD, this eye underwent a second surgical procedure consisting of vitrectomy revision and macular surgery, which includes BBG dye-assisted ERM/ILM peeling en-bloc removal technique and silicon oil injection. Lighter-than-water silicon oil was uneventfully removed 4 months later. After a 15-month follow-up, the final postoperative BCVA was 20/80 (logMAR 0.60) and showed a SD-OCT pattern consistent with an abnormal macular profile and presence of abnormal biomarkers, such as

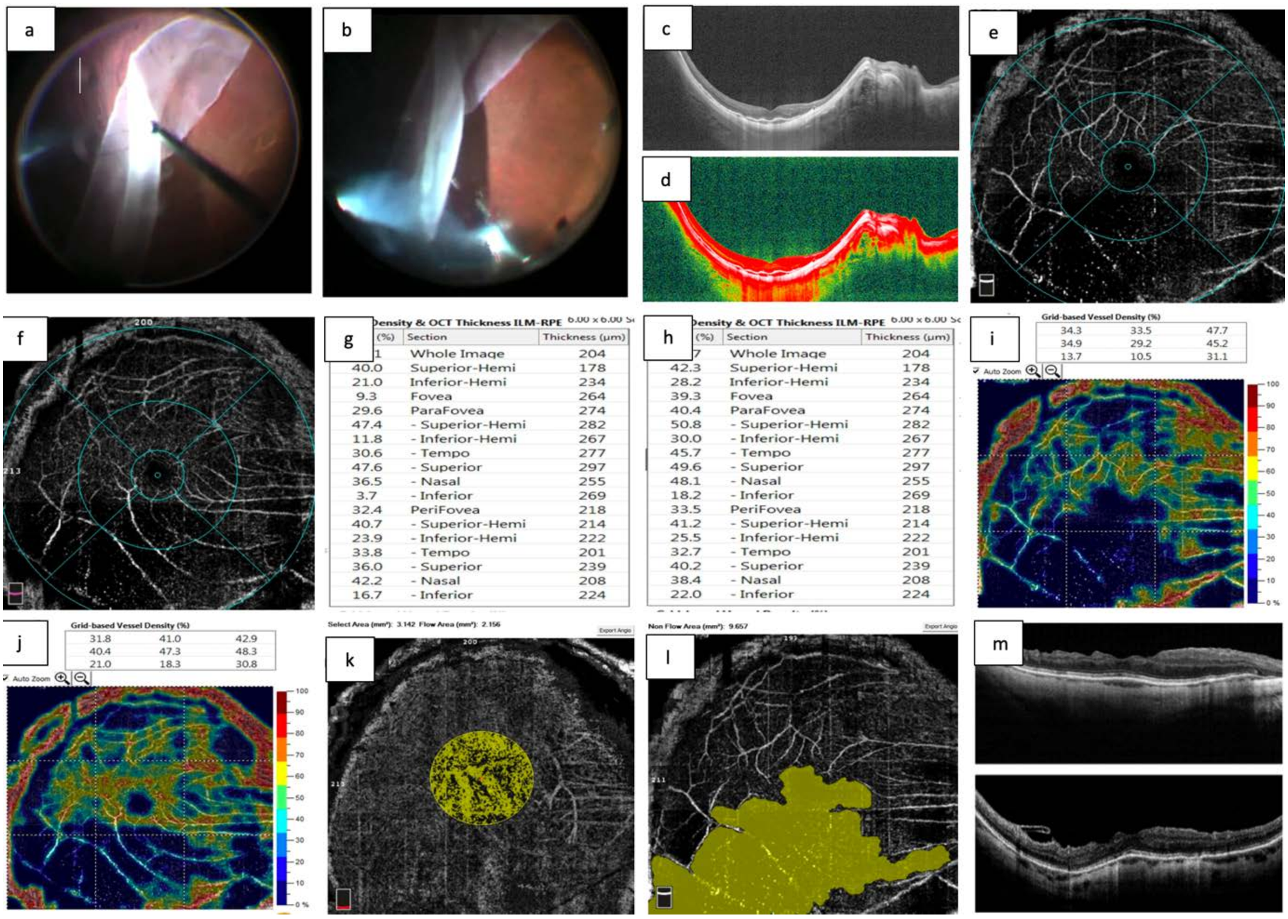

Figure 5. Surgical case 3. (a) and (b) Transoperative photos of a 39-year-old man with 2 days of sudden decrease in vision with metamorphopsia and high myopia. The patient was diagnosed with familial Stickler's syndrome by the genetic unit. A diagnosis of GRT-associated RRD of more than 270˚ extension was made. Counting fingers at 2 ft was assigned to a visual acuity of 20/2000 during preoperative BCVA (logMAR 2.00), with posterior staphyloma and an axial length of 30.1 mm (The clinical images a and b were adopted from a previous publication (18) from our group). (c) and (d) Images after a 15-month follow-up showing an SD-OCT pattern consistent with an abnormal macular profile and the presence of abnormal biomarkers (such as inner and irregular outer retina SD-OCT layers), abnormal subfoveal ellipsoid zone, and ELM line discontinuities with a well-preserved RPE layer. (e) and (f) The images depict superficial and deep vascular plexuses with the ETDRS-like sector grid overlay. (g) and (h) The images show different perfusion values and corresponding retinal thickness at different subregions of the macula. (i) and (j) The images show the color overlays in the OCT angiography images indicative of superficial and deep vessel density values in the key to the right; the quantified perfusion indices on the different subregions of the macula are depicted above. (k) The image shows a choriocapillaris flow area of 2.156 mm^2. (l) Highly abnormal, enlarged, irregular foveal avascular non-perfused area of 9.657 mm^2. (m) Long-term, postoperative central crossline b scan with an irregular foveal profile, internal limiting membrane remnants, external limiting membrane discontinuities and dissociated optic nerve fibers layers defects. ETDRS: early treatment diabetic retinopathy study, BCVA: best corrected visual acuity, ETDRS: OCT: optical coherence tomography, SD: spectral domain.

inner and outer retina SD-OCT layers, abnormal subfoveal EZ, and ELM line discontinuities with a well-preserved RPE layer (Figure 5(c) and Figure 5(d)). Further, the en-face aspect exhibited multiple deep defects at the level of the RPE cells with a highly abnormal perfusion evaluation on the SVP slab (Figure 5(e)) and a better perfusion evaluation on the DVP slab (Figure 5(f)). The superficial (Figure 5(g)) and deep (Figure 5(h)) perfusion indices and the corresponding retinal thickness values at different subregions of the retina were lower than normal. Color overlays on the OCT angiography images indicate superficial (**Figure 5(i)**) and deep (**Figure 5(j)**) Lower-than-normal quantified VD values at the different subregions of the macula seen in the key to the right and the VD percentage of the perfusion indices shown above the images were considered lower than normal. The choriocapillaris flow was highly deficient with 1.366 mm^2 of flow from a selected area of 3.142 mm^2 (**Figure 5(k)**). The FAZ area looked irregular and enlarged with 9.657 mm^2 in area (**Figure 5(l)**). The last long-term structural crossline SD-OCT b scan evaluation revealed an irregular foveal profile, irregular diffuse retinal thinning over the temporal and inferior side of the macula in both horizontal and vertical b scans respectively, evidence of dissociated optic nerve fiber defects, and irregularities in outer retina layer biomarkers (**Figure 5(m)**).

4. Discussion

The benefits of adding an encircling SB to vitrectomy for GRT-associated RRD are still largely unknown [23] [24]. Some authors claim that an abnormal vitreous base and decreasing support of tractional forces in that region could cause a break that leads to GRTs [25] [26] [27]. In eyes undergoing vitreous surgery for GRT-associated RRD, the value of adding a scleral buckle remains controversial because its placement before reapplying the retina although facilitates the removal of the anterior vitreous it favors the posterior slippage of the retina and additionally hypothetically induces potential damage to the retinal and choroidal microcirculation, that's one of the reasons why we preferably place the scleral buckle after transoperative fully reattachment of the retina if we decide to place it; others believe that buckling is an essential part of the surgical approach, as it helps to relieve the traction at the edges of the GRT and provides support for the rest of the vitreous base mainly at its posterior border [27]. Our analysis of long-term postoperative perfusion findings suggests a time-related change in perfusion density. The data showed reduced perfusion (both retinal and choroidal) after the control-perfusion vitrectomy technique. There was also a uniform reduction in the choroidal vessel network, which was evident in the topographical sub-analysis of the flow area. Previous studies have reported several histopathological harmful consequences of surgical maneuvers for the placement of SBs, which we could avoid [23] [24]. Cases with a complementary SB were purposefully excluded, as this may influence the perfusion state of the microvasculature system of the retina and vitreous.

There is a consensus among retinal surgeons to use SB in GRTs < 180˚, especially when there is no PVD and retinal folding. However, other retinal surgeons think that it may not be a proper technique because GRT > 180˚ increases the chances of vitreous traction. Therefore, SB may not have any benefits but increases the chances of complications. The long term perfusion status was evaluated as previously described [28]. A sustained vessel density due to enhanced perfusion can improve vision and prevent its deterioration [29]. Further, myopic eyes with decreased choroidal perfusion may be attributed to the mechanical stretch forces that arise due to elongation of the eyeball [30]. However, this possibility could not be proven in our case series.

Based on our observations and previous studies, it is evident that assessment of microcirculation provides a key clinical benefit [29], especially because in several diseases such as retinal vascular diseases, including diabetic retinopathy, macular telangiectasia, and radiation retinopathy, small vessel changes with lower vessel density have been well documented [23] [31] [32].

OCT angiography quantitative perfusion indices can reproducibly facilitate the detection of postoperative structural outcomes. We observed that visual acuities were correlated to the flow area of the CSP slabs. However, the small sample size limited our observations and comparisons. We compared normal-range vessel changes in three groups of eyes: a normal emmetropic eye, a highly myopic eye, and in eyes with different degrees of GRT-associated extensions of RRD, and we observed differences in macular perfusion indices between the control eye and those with GRT-related RRD. Significant differences were found when the microcirculation of the macula was analyzed using quantitative VD perfusion indices. These perfusion deficiencies suggest a possible causal relationship between the perfusion mechanisms and lack of better visual recovery in this condition [18]. Similar effects have been published by Christou, [33] suggesting that postoperative OCT angiography findings are a hypothetical explanation of suboptimal vision recovery without current evidence to establish OCT angiography biomarkers as predictive factors.

Our case studies provide support for the role of microcirculation as a fundamental player in postoperative visual recovery. Several studies have directly examined the correlation between choroidal perfusion and VD. Care should be taken to avoid reduction of the choroidal perfusion in eyes with GRTs associated with RRD due to surgical changes (e.g., by compression of the choroid secondary to buckling surgery) [33]. FAZ distortion with enlargement of the juxtafoveal capillary net contributes to decreased VD perifoveal perfusion indices in the different stages of myopic traction maculopathy [19]; this fact should be proven in successfully operated eyes with GRT-associated RRD.

We observed a positive correlation between BCVA and macular perfusion indices across different degrees of GRT-associated extensions of RRD, which suggests that VD flow abnormalities (lower value of choroidal thickness) may correspond to lack of visual recoveries. It is important to note that the current control-perfusion vitrectomy techniques are crucial to reversing the state of the eye. Similarly, it is important to complete the reattachment procedures for the retina to avoid complications that would otherwise arise. In our cases, early performance of the procedure prevented future damage to the eye. However, patients with a tear magnitude of 180˚ - 270˚ had the best probability of survival, whereas patients with a tear magnitude > 270˚ had the worst survival rate. Thus, these patients must be treated quickly to avoid irreversible visual damage.

We did not apply endolaser even for GRTs of <180˚ because there is no evidence in the literature to support the use of 360˚ endolaser in the absence of lattice degeneration [26]. However, we performed extensive assisted vitreous base shaving. Fluid-air exchange is arguably the most critical step in the surgical repair of GRT-associated RRDs, and an improper technique can result in retinal slippage or retinal fold formation. Meticulous, slow aqueous removal with an extrusion cannula at the air-perfluorocarbon liquid interface and at the edge of the tear is essential. We did not observe any occurrence of macular retinal folds due to posterior slippage in eyes with GRTs < 180˚ or in GRTs > 180˚. Moreover, we could not investigate the benefits of SB in our surgeries as we did not include this type of cases in this preliminary report; however, it should be noted that some surgeons insist on using this technique, whereas others do not [25]. We also did not use short-acting gas (sulfur hexafluoride) in our patients because it is known to cause high rates of re-detachment [34]. However, we used C_3F_8 in all cases regardless of the extent of GRT. Lighter-than-water silicone was used as a tamponade only in an eye with PVR and was eventually removed while preserving the attached retina. Several factors may lead to the decision of using a tamponade agent. For example, Kunikata *et al.* [35] used silicone oil as a tamponade in 34 of 41 eyes (83%) with GRT-associated RRD.

The risk factors that cause the recurrence of RRD include anterior PVR and persistent or new epiretinal traction at the corners of the tear [1] [2]. We observed RRD recurrence in one patient due to posterior PVR with evidence of postoperative ERM proliferation over the detached macula. We believe that it contributed to the creation or activation of new tears through diffuse posterior epiretinal traction. The eye with recurrent RRD underwent vitrectomy revision, epiretinal and macular membrane stripping, and ERM/ILM en-bloc removal during the follow-up.

The rate of reattachment following one procedure is reportedly 80% - 90%, whereas the final reattachment rate is 94% - 100% [12] [36]. However, if PVR is present, the visual prognosis is poor despite reattachment and anatomic success, as was demonstrated here and in a previous study [2]. In contrast, in a previous report, the most common postoperative complications, including macular ERM proliferation and cystoid macular edema, occurred in 16 eyes (39%) [35]. Some authors believe that [36] good anatomical and functional results can be obtained only with vitrectomy techniques in non-complex cases. In our study, we observed a 66.7% rate of reattachment after one surgical procedure, which is consistent with the 65% rate at 2 years (95% confidence interval: 47% - 78%) reported by Li *et al.* [36].

A prospective study reported that even eyes that underwent timely surgery hardly achieved a recovery of vision of 20/40 or better, highlighting the difficult management of the condition, [37]. We believe that the absence of SB does not seem to influence the final functional results, as indicated by our data. In fact, the factors that lead to poor visual outcomes include old age (over 70 years), low IOP (<10 mmHg), retinal detachment with more than four rhegmatogenous lesions, and retinal detachment of more than three quadrants [37]. However, it is now clear that the final visual outcome is correlated with the perfusion indices. Therefore, we hypothesize that both the extensive pathological rupture of the retina as well as the vitrectomy techniques can potentially damage the microcirculation of the retina and choroid, this hypothetically accentuated perhaps in the long-term by the presence of SB resulting in low rates of perfusion and unsatisfactory postoperative vision. We did not find any association between anatomic success and other factors, namely number of breaks, lens extraction, additional cryotherapy, and type of surgery (primary vitrectomy vs. combined SB and vitrectomy techniques), which is in agreement with a report by Ting *et al.* [38]. In our study, the postoperative BCVA in logMAR units was significantly associated with the CSFT in microns, the normal foveal contour, and the abnormal perfusion indices according to our statistical analysis. We observed that the thinner the CSFT and lower the perfusion indices, the lower the postoperative BCVA. The preoperative logMAR was higher in tear > 270˚ and the final postoperative logMAR in the same eye was lower. The results of this study reaffirm the hypothetical concept of the author that the greater the extent of the giant tear, the less need to place a scleral buckle; the previous clinical fact supported by our results where the worst perfusional indices were observed precisely in giant tears greater than 180 treated with complementary scleral cerclage and this outcome positively correlates with the worst final BCVA.

The two main limitations of this study are its retrospective nature and low sample size. However, it also has inherent strengths, such as its long-term follow-up evaluation. Additionally, the data reported here were collected by a single surgeon to avoid surgeon bias. Further, the paucity of studies on GRT-associated RRD allowed us to correlate structural and functional outcomes with perfusion outcomes, which have been insufficiently explored in this relatively rare condition.

5. Conclusion

To conclude, GRT-associated RRD remains a potentially blinding condition with limited final functional outcomes despite the recent advances in the management of this condition. The advancement in technology has improved our understanding of the anatomical structures and the ways to treat the disease; however, the assessment of perfusion status is still a new concept. It should be noted that surgical timing is important in reducing long-term complications, minimizing the complication rate, and improving the reattachment rate. Evaluation of patients for long-term perfusion and functional outcomes suggests a role of these indices in better patient management. Additionally, as GRT-associated RRD is a rare condition, the data presented here have significant clinical implications. The most important outcomes of this study concerning the management of GRT-associated RRD include the benefits of thorough control-perfusion vitrectomy and the postoperative macular perfusion indices, which allowed us to conclude the importance of evaluating pre- and postoperative macular perfusion indices in patients with this condition to perform surgical techniques with transoperative control of perfusion, and preferably without the assistance of complementary scleral cerclages, which according to published clinical evidence are unnecessary and potentially harmful to retinomacular perfusion.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Ang, G.S., Townend, J. and Lois, N. (2009) Interventions for Prevention of Giant Retinal Tear in the Fellow Eye. *Cochrane Database of Systematic Reviews*, No. 2, CD006909. https://doi.org/10.1002/14651858.CD006909.pub2

[2] Ang, G.S., Townend, J. and Lois, N. (2010) Epidemiology of Giant Retinal Tears in the United Kingdom: The British Giant Retinal Tear Epidemiology Eye Study (BGEES). *Investigative Ophthalmology & Visual Science*, **51**, 4781-4787. https://doi.org/10.1167/iovs.09-5036

[3] Shunmugam, M., Ang, G.S. and Lois, N. (2014) Giant Retinal Tears. *Survey of Ophthalmology*, **59**, 192-216. https://doi.org/10.1016/j.survophthal.2013.03.006

[4] Freeman, H.M. (1978) Fellow Eyes of Giant Retinal Breaks. *Transactions of the American Ophthalmological Society*, **76**, 343-382.

[5] Wood, M.L. and Gilbert, C. (2002) Retinal Detachment in East Africa. *Ophthalmology*, **109**, 2279-2283. https://doi.org/10.1016/S0161-6420(02)01284-8

[6] Chou, S., Yang, C.H., Lee, C.H., *et al.* (2007) Characteristics of Primary Rhegmatogenous Retinal Detachment in Taiwan. *Eye*, **21**, 1056-1061. https://doi.org/10.1038/sj.eye.6702397

[7] Malbran, E., Dodds, R.A., Hulsbus, R., *et al.* (1990) Retinal Break Type and Proliferative Vitreoretinopathy in Nontraumatic Retinal Detachment. *Graefe's Archive for Clinical and Experimental Ophthalmology*, **228**, 423-425.

https://doi.org/10.1007/BF00927254

[8] Ghosh, Y.K., Banerjee, S., Savant, V., *et al.* (2004) Surgical Treatment and Outcome of Patients with Giant Retinal Tears. *Eye*, **18**, 996-1000. https://doi.org/10.1038/sj.eye.6701390

[9] Nagpal, M. (2013) Giant Retinal Tears: Size Does Matter. *Retina Today*, 26-28.

[10] Asaria, R.H., Kon, C.H., Bunce, C., *et al.* (2001) Adjuvant 5-Fluorouracil and Heparin Prevents Proliferative Vitreoretinopathy: Results from a Randomized, Double-Blind, Controlled Clinical Trial. *Ophthalmology*, **108**, 1179-1183. https://doi.org/10.1016/S0161-6420(01)00589-9

[11] Cahill, M.T., Barry, P.J. and Kenna, P.F. (1998) Giant Retinal Tear in Usher Syndrome Type II: Coincidence or Association? *Retina*, **18**, 177-178. https://doi.org/10.1097/00006982-199818020-00016

[12] Sharma, A., Grigoropoulos, V. and Williamson, T. (2004) Management of Primary Rhegmatogenous Retinal Detachment with Inferior Breaks. *British Journal of Ophthalmology*, **88**, 1372-1375. https://doi.org/10.1136/bjo.2003.041350

[13] Pitcher, J., Khan, M., Storey, P., *et al.* (2013) Giant Retinal Tear Detachments: Surgical Strategies and Outcomes. *Investigative Ophthalmology & Visual Science*, **54**, 2864.

[14] D'Aloisio, R., Viggiano, P., Borrelli, E., *et al.* (2020) Changes in Iris Perfusion Following Scleral Buckle Surgery for Rhegmatogenous Retinal Detachment: An Anterior Segment Optical Coherence Tomography Angiography (AS-OCTA) Study. *Journal of Clinical Medicine*, **9**, Article No. 1231. https://doi.org/10.3390/jcm9041231

[15] Hassan, T.S., Sarrafizadeh, R., Ruby, A.J., *et al.* (2002) The Effect of Duration of Macular Detachment on Results after the Scleral Buckle Repair of Primary, Macula-Off Retinal Detachments. *Ophthalmology*, **109**, 146-152. https://doi.org/10.1016/S0161-6420(01)00886-7

[16] Kwartz, J., Charles, S., McCormack, P., Jackson, A. and Lavin, M. (1994) Anterior Segment Ischaemia Following Segmental Scleral Buckling. *The British Journal of Ophthalmology*, **78**, 409-410. https://doi.org/10.1136/bjo.78.5.409

[17] Doi, N., Uemura, A. and Nakao, K. (1999) Complications Associated with Vortex Vein Damage in Scleral Buckling Surgery for Rhegmatogenous Retinal Detachment. *Japanese Journal of Ophthalmology*, **43**, 232-238. https://doi.org/10.1016/S0021-5155(99)00009-X

[18] Quiroz-Reyes, M.A., Quiroz-Gonzalez, E.A., Quiroz-Gonzalez, M.A., Alsaber, A.R., Montano, M., *et al.* (2022) Critical Analysis of Postoperative Outcomes in Rhegmatogenous Retinal Detachment Associated with Giant Tears: A Consecutive Case Series Study. *International Journal of Ophthalmology and Clinical Research*, **9**, Article No. 134. https://doi.org/10.21203/rs.3.rs-821184/v1

[19] Quiroz-Reyes, M.A., Quiroz-Gonzalez, E.A., Morales-Navarro, J., *et al.* (2021) Structural and Perfusional Findings in Surgically Resolved Myopic Foveoretinal Detachment Eyes and those in Early Stages of Myopic Traction Maculopathy. *Journal of Clinical and Experimental Ophthalmology*, **12**, Article No. 893.

[20] Klufas, M.A., Phasukkijwatana, N., Iafe, N.A., *et al.* (2017) Optical Coherence Tomography Angiography Reveals Choriocapillaris Flow Reduction in Placoid Chorioretinitis. *Ophthalmology Retina*, **1**, 77-91. https://doi.org/10.1016/j.oret.2016.08.008

[21] Kuehlewein, L., Bansal, M., Lenis, T.L., *et al.* (2015) Optical Coherence Tomography Angiography of Type 1 Neovascularization in Age-Related Macular Degeneration.

American Journal of Ophthalmology, **160**, 739-748.E2.
https://doi.org/10.1016/j.ajo.2015.06.030

[22] Staurenghi, G., Sadda, S., Chakravarthy, U., *et al.* (2014) Proposed Lexicon for Anatomic Landmarks in Normal Posterior Segment Spectral-Domain Optical Coherence Tomography: The IN·OCT Consensus. *Ophthalmology*, **121**, 1572-1578.
https://doi.org/10.1016/j.ophtha.2014.02.023

[23] Ogasawara, H., Feke, G.T., Yoshida, A., *et al.* (1992) Retinal Blood Flow Alterations Associated with Scleral Buckling and Encircling Procedures. *The British Journal of Ophthalmology*, **76**, 275-279. https://doi.org/10.1136/bjo.76.5.275

[24] Diddie, K.R. and Ernest, J.T. (1980) Uveal Blood Flow after 360˚ Constriction in the Rabbit. *Archives of Ophthalmology*, **98**, 729-730.
https://doi.org/10.1001/archopht.1980.01020030723016

[25] Goezinne, F., La Heij, E.C., Berendschot, T.J.M., *et al.* (2008) Low Redetachment Rate Due to Encircling Scleral Buckle in Giant Retinal Tears Treated with Vitrectomy and Silicone Oil. *Retina*, **28**, 485-492.
https://doi.org/10.1097/IAE.0b013e318150d879

[26] Verstraeten, T., Williams, G.A., Chang, S., *et al.* (1995) Lens-Sparing Vitrectomy with Perfluorocarbon Liquid for the Primary Treatment of Giant Retinal Tears. *Ophthalmology*, **102**, 17-20. https://doi.org/10.1016/S0161-6420(95)31063-9

[27] Lakhanpal, R.R. and Hariprasad, S.M. (2015) Strategic Planning Ensures Surgical Success in Cases of Proliferative Vitreoretinopathy. *Ophthalmic Surgery, Lasers and Imaging Retina*, **46**, 155-157. https://doi.org/10.3928/23258160-20150213-13

[28] Wang, S.W., Hsia, Y., Huang, C.J., *et al.* (2021) Biomarkers in the Pathogenesis of Epiretinal Membrane and Myopic Traction Maculopathy: Effects of Internal Limiting Membrane Incompliance and Posterior Staphyloma. *Photodiagnosis and Photodynamic Therapy*, **33**, Article ID: 102208.
https://doi.org/10.1016/j.pdpdt.2021.102208

[29] Kumagai, K., Furukawa, M., Ogino, N. and Larson, E. (2010) Factors Correlated with Postoperative Visual Acuity after Vitrectomy and Internal Limiting Membrane Peeling for Myopic Foveoschisis. *Retina*, **30**, 874-880.
https://doi.org/10.1097/IAE.0b013e3181c703fc

[30] Al-Sheikh, M., Phasukkijwatana, N., Dolz-Marco, R., *et al.* (2017) Quantitative OCT Angiography of the Retinal Microvasculature and the Choriocapillaris in Myopic Eyes. *Investigative Ophthalmology & Visual Science*, **58**, 2063-2069.
https://doi.org/10.1167/iovs.16-21289

[31] Sakata, K., Funatsu, H., Harino, S., *et al.* (2006) Relationship between Macular Microcirculation and Progression of Diabetic Macular Edema. *Ophthalmology*, **113**, 1385-1391. https://doi.org/10.1016/j.ophtha.2006.04.023

[32] Chin, E.K., Kim, D.Y., Hunter, A.A., *et al.* (2013) Staging of Macular Telangiectasia: Power-Doppler Optical Coherence Tomography and Macular Pigment Optical Density. *Investigative Ophthalmology & Visual Science*, **54**, 4459-4470.
https://doi.org/10.1167/iovs.12-11116

[33] Christou, E.E., Stavrakas, P., Batsos, G., *et al.* (2021) Association of OCT-A Characteristics with Postoperative Visual Acuity after Rhegmatogenous Retinal Detachment Surgery: A Review of the Literature. *International Ophthalmology*, **41**, 2283-2292.
https://doi.org/10.1007/s10792-021-01777-2

[34] Gonzalez, M.A., Flynn Jr., H.W., Smiddy, W.E., *et al.* (2013) Surgery for Retinal Detachment in Patients with Giant Retinal Tear: Etiologies, Management Strategies, and Outcomes. *Ophthalmic Surgery, Lasers and Imaging Retina*, **44**, 232-237.

https://doi.org/10.3928/23258160-20130503-04

[35] Kunikata, H., Aizawa, N., Sato, R., *et al.* (2020) Successful Surgical Outcomes after 23-, 25- and 27-Gauge Vitrectomy without Scleral Encircling for Giant Retinal Tear. *Japanese Journal of Ophthalmology*, **64**, 506-515. https://doi.org/10.1007/s10384-020-00755-y

[36] Li, K.X., Carducci, N., Moinuddin, O., *et al.* (2021) Contemporary Management of Complex and Non-Complex Rhegmatogenous Retinal Detachment Due to Giant Retinal Tears. *Clinical Ophthalmology*, **15**, 1013-1022. https://doi.org/10.2147/OPTH.S299762

[37] Baba, T., Kawasaki, R., Yamakiri, K., *et al.* (2021) Visual Outcomes after Surgery for Primary Rhegmatogenous Retinal Detachment in Era of Microincision Vitrectomy: Japan-Retinal Detachment Registry Report IV. *British Journal of Ophthalmology*, **105**, 227-232.

[38] Ting, D.S.W., Foo, V.H.X., Tan T.E., *et al.* (2020) 25-Years Trends and Risk Factors Related to Surgical Outcomes of Giant Retinal Tear-Rhegmatogenous Retinal Detachments. *Scientific Reports*, **10**, Article No. 5474. https://doi.org/10.1038/s41598-020-61592-0