Microvascular Changes After Scleral Buckling For Rhegmatogenous Retinal Detachment: An Optical Coherence Tomography Angiography Study

Matteo Fallico
University of Catania
Antonio Longo (antlongo@unict.it)
University of Catania
Teresio Avitabile
University of Catania
Pietro Alosi
University of Catania
Marco Grillo
University of Catania
Niccolò Castellino
University of Catania
Vincenza Bonfiglio
University of Palermo
Michele Reibaldi
University of Turin
Andrea Russo
University of Catania

Article

Keywords:

Posted Date: April 8th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1486158/v1

Abstract

This retrospective study aimed at investigating macular microvascular alterations after successful scleral buckling (SB) for rhegmatogenous retinal detachment (RRD). Nine-teen eyes with macula-on RRD and 18 eyes with macula-off RRD were included. In all cases an encircling band was placed. Optical coherence tomography angiography (OCTA) was performed at baseline and postoperatively. Changes in foveal avascular zone (FAZ) area and vessel density (VD) of the superficial capillary plexus (SCP) and deep capillary plexus (DCP) were the primary outcome. Correlations between OCTA findings and clinical variables were considered as secondary outcome. In both macula-on and macula-off groups, FAZ area was comparable with controls. In the macula-on group, VD in the whole SCP was lower compared with controls at both baseline ($P < 0.001$) and 6 months ($P = 0.03$), but showed a significant increase after surgery ($P = 0.004$). In the macula-off group, postoperative VD in both whole SCP and whole DCP was lower compared with controls ($P < 0.001$). In the macula-on group, there was an inverse correlation between axial length increase and SCP VD change ($r=-0.508; P = 0.03$). These findings demonstrated microvascular alterations after SB for RRD. However, VD impairment seems to mitigate after the surgery. A greater increase in postoperative axial length was associated with a poorer VD outcome.

Introduction

Scleral buckling (SB) is a valuable treatment option for rhegmatogenous retinal detachment (RRD), being preferred over vitrectomy in cases of phakic eyes with uncomplicated or medium complexity detachments.[1,2] Most commonly, surgery involves the use of an encircling band, placed posteriorly to the vitreous base, aimed at relieving vitreoretinal traction and protecting from degenerative processes of the vitreous base.[3,4]

Circumferential buckles, in particular encircling bands, cause significant changes to eyeball anatomy, secondary to their pressure exerted on the sclera. The ultimate consequence is an increase in axial length.[5] These anatomical changes, in turn, might cause microvascular alterations.[6,7]

Optical coherence tomography angiography (OCTA) is a novel, noninvasive imaging method that provides qualitative and quantitative information on macular microcirculation.[8] OCTA has been recently used to evaluate macular microvascular changes occurring after successful RRD surgery.[9–17] In particular, many authors investigated microvascular alterations following vitrectomy surgery, while less attention has been paid on the effect of scleral buckling on macular microvascular condition.

The purpose of this study was to evaluate macular vessel density on OCTA following scleral buckling for RRD and to identify which clinical variables might have an influence on macular microvascular status. Additionally, relationships between microvascular parameters and functional and anatomical outcomes were explored.

Results

A total of 37 eyes were included, of which 19 were in the macula-on group and 18 in the macula-off group. Baseline demographics and ocular characteristics are shown in Table 1.

Table 1
Baseline demographic and ocular characteristics of included patients.

	Macula-on group	Macula-off group	p
Eyes (n.)	19	18	
Gender (male/female)	9/10	10/8	0.862
Age (years)	54 ± 6	56 ± 7	0.356
BCVA (logMAR)	0.10 ± 0.03	0.94 ± 0.07	< 0.001
Axial lenght (mm)	25.2 ± 0.5	24.8 ± 1.1	0.101
Data are expressed as mean ± SD			
BCVA: best-corrected visual acuity; logMAR: logarithm of the minimum angle of resolution			
mm = millimeters			

Macula-on Rrd Group

Clinical and OCTA parameters of the macula-on RRD group are summarized in Table 2. Baseline mean BCVA was 0.10 ± 0.03 logMar and remained unchanged throughout the follow-up. Mean axial length increased from a baseline value of 25.2 ± 0.5 mm to 26.1 ± 0.8 mm at 6 months ($P < 0.001$). Mean baseline FAZ area was 0.227 ± 0.02 mm^2 and remained unchanged following SB surgery. Mean baseline CMT was 244 ± 13 microns, with no significant change following SB surgery. Both mean FAZ area and CMT in RRD eyes were comparable with controls. Baseline VD in the whole SCP was lower in RRD eyes compared with controls ($P < 0.001$). A significant increase of VD in the whole SCP was demonstrated in RRD eyes following SB surgery (ANOVA, $P = 0.004$); however, 6-month VD in the whole SCP was lower compared with controls ($P = 0.03$). Similarly, SCP VD increased during the follow-up in the parafoveal and perifoveal subfields (parafoveal SCP, $P = 0.005$; perifoveal SCP, $P = 0.001$), while it remained unchanged in the foveal subfield ($P = 0.07$). Vessel density in the foveal SCP was comparable between RRD eyes and controls at both baseline ($P = 0.83$) and 6 months postoperatively ($P = 0.74$). In parafoveal and perifoveal subfileds of the SCP, VD was lower in RRD eyes compared with controls at both baseline (parafoveal SCP, $P < 0.001$; perifoveal SCP, $P < 0.001$) and 6 months postoperatively (parafoveal SCP, $P = 0.02$; perifoveal SCP, $P = 0.04$). Vessel density in the DCP did not show any significant change following SB surgery and was comparable with controls. Figure 1shows baseline and postoperative OCTA imaging in a case of macula on RRD.

Table 2
Clinical and OCTA parameters of the macula-on RRD group

Macula-on RRD eyes, n 19						***Control eyes, n 19***		
	baseline	**1 month**	**3 months**	**6 months**	*p (ANOVA)*	**baseline**	p^a	p^b
BCVA	0.10 ± 0.03	0.09 ± 0.04	0.09 ± 0.05	0.09 ± 0.03	*0.687*	0.07 ± 0.03	*0.003*	*0.023*
axial length	25.2 ± 0.5			26.1 ± 0.8	< 0.001 *(t-test)*	26.0 ± 1.5	0.014	*0.762*
FAZ	0.227 ± 0.019	0.230 ± 0.007	0.221 ± 0.015	0.229 ± 0.016	*0.310*	0.226 ± 0.014	*0.863*	*0.561*
CMT (µm)	244 ± 13	250 ± 10	252 ± 9	249 ± 11	*0.197*	246 ± 12	*0.612*	*0.351*
Vessel density								
SCP whole	40.9 ± 1.8[c]	42.1 ± 2.2	42.6 ± 1.6[c]	43.1 ± 2.2[d]	0.004	44.3 ± 1.6	< 0.001	0.034
SCP fovea	21.4 ± 2.8	20.1 ± 2.9	19.8 ± 1.4	21.3 ± 1.7	*0.073*	21.5 ± 1.7	*0.826*	*0.743*
SCP parafovea	41.0 ± 2.6	43.1 ± 1.9	43.5 ± 1.7[e]	43.6 ± 1.4[f]	0.005	45.6 ± 1.5	< 0.001	0.022
SCP perifovea	40.7 ± 2.4	39.9 ± 1.4	40.6 ± 1.4	42.7 ± 2.8[g]	0.001	44.4 ± 1.8	< 0.001	0.035
DCP whole	48.8 ± 1.8	49.7 ± 1.3	49.4 ± 1.7	49.4 ± 2.1	*0.481*	50.1 ± 2.1	*0.065*	*0.210*
DCP fovea	40.7 ± 1.4	40.2 ± 1.7	40.9 ± 2.0	41.1 ± 1.2	*0.320*	41.6 ± 1.5	*0.078*	*0.336*
DCP parafovea	52.1 ± 2.3	51.1 ± 1.6	50.8 ± 2.2	51.4 ± 2.7	*0.320*	52.6 ± 2.1	*0.530*	*0.136*
DCP perifovea	48.2 ± 2.9	49.2 ± 1.8	47.8 ± 2.8	48.4 ± 3.1	*0.432*	49.4 ± 2.9	*0.200*	*0.275*

Footnote: OCTA, optical coherence tomography angiography; RRD, rhegmatogenous retinal detachment; n, number; BCVA, best corrected visual acuity; logMar, logarithm of minimum angle of resolution; FAZ, foveal avascular zone; CMT. Central Macular Thickness; SCP, superficial capillary plexus; DCP, deep capillary plexus; p^a: p value between baseline macula-on group versus baseline control group; p^b: p value between 6-month macula-on group versus baseline control group; P (Tukey HSD vs baseline) c = 0.040, d = 0.003, e = 0.012, f = 0.008, g = 0.021

Axial length change was shown to correlate with mean change in VD of the whole SCP ($r = -0.508$, $P = 0.03$), perifoveal SCP ($r = -0.546$, $P = 0.02$) and parafoveal SCP ($r = -0.684$, $P = 0.001$). In all cases, an increase in axial length was associated with poorer VD outcome (Fig. 2). No other significant correlations were found.

Macula-off Rrd Group

Clinical and OCTA parameters of the macula-off RRD group are summarized in Table 3. Baseline mean BCVA improved following SB surgery, from 1.04 ± 0.09 logMar at baseline to 0.25 ± 0.08 logMar at 6 months ($P < 0.001$). Mean axial length increased from 24.9 ± 0.5 mm to 26.2 ± 0.7 mm at 6 months ($P = 0.001$). Baseline OCTA parameters were not available. Following SB surgery, from month 1 to month 6, no significant change in both mean CMT and mean FAZ area was found. Both 6-month CMT and FAZ area were comparable with controls (FAZ, $P = 0.26$; CMT, $P = 0.18$).

Table 3
Clinical and OCTA parameters of the macula-off RRD group

Macula-off RRD eyes, n 18						Control eyes, n 18	
	baseline	**1 month**	**3 months**	**6 months**	*p (ANOVA)*	**baseline**	*p^a*
BCVA (logMar)	1.04 ± 0.09	0.30 ± 0.10 a	0.26 ± 0.08 a	0.25 ± 0.08 a	**< 0.001**	0.09 ± 0.04	**< 0.001**
axial length (mm)	24.9 ± 0.5			26.2 ± 0.7	**0.001 (t-test)**	25.6 ± 0.8	**0.037**
FAZ	NA	0.231 ± 0.031	0.218 ± 0.017	0.226 ± 0.013	0.224	0.231 ± 0.010	0.255
CMT (μm)	NA	273 ± 14	276 ± 13	275 ± 15	0.316	269 ± 11	0.177
Vessel density							
SCP whole	NA	40.5 ± 1.4	40.6 ± 1.3	41.3 ± 1.7	0.054	44.6 ± 1.1	**< 0.001**
SCP fovea	NA	20.1 ± 1.4	20.5 ± 1.0	20.9 ± 1.6	0.108	20.5 ± 1.6	0.545
SCP parafovea	NA	41.5 ± 1.6	41.6 ± 1.3	41.6 ± 1.9	0.689	45.1 ± 1.5	**< 0.001**
SCP perifovea	NA	40.3 ± 1.7	40.6 ± 1.4	41.0 ± 1.5	0.108	43.5 ± 1.3	**< 0.001**
DCP whole	NA	41.0 ± 1.6	43.6 ± 1.2^b	43.9 ± 1.7^b	**< 0.001**	46.5 ± 1.2	**< 0.001**
DCP fovea	NA	35.4 ± 2.4	36.3 ± 1.9	36.2 ± 1.8	0.068	37.7 ± 1.0	**0.004**
DCP parafovea	NA	45.0 ± 1.4	46.1 ± 1.7	48.6 ± 2.6^b	**< 0.001**	51.8 ± 2.1	**< 0.001**
DCP perifovea	NA	40.4 ± 2.1	40.9 ± 1.5	40.5 ± 2.9	0.317	47.2 ± 1.6	**< 0.001**

Footnote: OCTA, optical coherence tomography angiography; RRD, rhegmatogenous retinal detachment; n, number; BCVA, best corrected visual acuity; logMar, logarithm of minimum angle of resolution; FAZ, foveal avascular zone; CMT. Central Macular Thickness; SCP, superficial capillary plexus; DCP, deep capillary plexus; NA, not applicable; p^a: p value between 6-month macula-off group versus baseline control group; P (Tukey HSD vs 1 month) b < 0.001.

Following SB surgery, from month 1 to month 6, no significant change in VD of the SCP was shown. At 6 months, mean VD of the whole SCP was lower compared with controls (P < 0.001). At 6 months, a lower-than-controls VD was found in the parafoveal SCP and perifoveal SCP as well (parafoveal SCP, P < 0.001; perifoveal SCP, P < 0.001).

During the follow-up, from month 1 to month 6, VD significantly increased in the whole DCP ($P < 0.001$). Such a significant increase was found in the parafoveal DCP as well ($P < 0.001$). No VD change was seen in other subfields of the DCP. At 6 months, mean VD in DCP was lower compared with controls (whole DCP, $p < 0.001$; foveal DCP, $P = 0.004$, parafoveal DCP, $P < 0.001$; perifoveal DCP, $P < 0.001$). Figure 3 shows baseline and postoperative OCTA imaging in a case of macula off RRD.

Discussion

This study sought to investigate macular microvascular changes on OCTA imaging after scleral buckling for RRD, showing a postoperative reduction in vessel density of the superficial capillary plexus in both macula-on and macula-off RRDs. Postoperative vessel density of deep capillary plexus seems to be impaired in eyes affected by macula-off RRD, while it seems to be unchanged in macula-on RRDs.

Microvascular alterations in retinal and choroidal circulation occurring in RRD eyes have been long studied.[6,9,18] Before the advent of OCTA, other tools had been used.[6,18] Scanning laser Doppler flowmetry showed a decrease in macular flow in RRD eyes.[18] Such vascular changes have been supposed to be related to a reversible vasoconstriction, which could be secondary to tissue hypoxia.[9,19] In macula-off detachments, biological composition of subretinal fluid has been assumed to affect oxygen diffusion due to an increase of inflammatory mediators.[9,12,20] Consequently, microvascular changes and photoreceptor alterations are likely to occur in the macula and might not be fully restored even after anatomical re-attachment.[10,14,21] These alterations, in turn, may determine functional defects, such as suboptimal visual recovery, color vision impairment and persistent metamorphopsia.[9,21,22]

The introduction of OCTA imaging represented a significant breakthrough in the assessment of retinal microcirculation. Several studies have explored macular microvascular alterations on OCTA imaging following RRD repair surgery.[10–17, 23] Most available evidence is on vitrectomy cases.[12, 14–17,23] A few reports included both scleral buckling and vitrectomy cases. Barca et al found an augmentation in the FAZ area in the SB group compared with the vitrectomy group.[10] Tsen et al found no difference in the FAZ area and vessel density between eyes with and without a buckle.[11] Nam et al found a greater vessel density reduction in vitrectomy cases compared with SB cases.[13] However, to the best of our knowledge, no study has specifically focused on microvascular alterations on OCTA following scleral buckling for RRD.

According to the majority of studies on vitrectomy cases, vessel density of macular capillary plexi, both deep and superficial, is reduced after RRD surgery.[10,11,13,14,16,17,23] Hong et al analyzed macular vessel density of 31 eyes at 6 months from vitrectomy for RRD, including both macula-on and macula-off cases.[15] Their study showed no difference in mean vessel density of both DCP and SCP between RRD eyes and controls. These findings seem to be in disagreement with those reported by most studies, but need to be looked at in more detail. A possible explanation for these controversial results is the fact that vessel density seems to increase on a long-term follow-up. Some authors described a significantly reduced vessel density in the early post-operative period, which progressively increased throughout long-term follow-up.[10,13] Indeed, vessel density seems to be comparable between RRD eyes and controls between 6-to-12 months post-operatively.[10,13] Such a tendency could explain why Hong et al[15] were unable to prove microvascular alterations at 6 months after RRD surgery.

Our findings showed that vessel density featured a similar increasing trend over a 6-month follow-up after scleral buckling surgery for RRD. In eyes with macula-on RRD, baseline vessel density was reduced in the superficial capillary plexus compared with controls; following SB procedure, SCP vessel density increased over a 6-month period. In eyes with macula-off RRD, baseline OCTA was not available; in this group, vessel density in the deep capillary plexus significantly improved from month 1 to month 6 postoperatively.

Barca et al hypothesized that the impairment of vessel density of the superficial capillary plexus in eyes with macula-on RRD might be related to the fact that the SCP is the first vascular layer affected in case of a rapid increase of vascular resistance secondary to a recent retinal detachment.[10] The superficial capillary plexus is characterized by a greater density of smooth muscle and arterioles compared with the deep plexus. Consequently, vasoconstriction driven by tissue hypoxia is supposed to be stronger in the superficial plexus.[10] The improvement of SCP vessel density following successful RRD repair seems to confirm this hypothesis. Our findings in the macula-on cohort corroborated this. Furthermore, our correlation analysis between axial length change and vessel density provides a new insight in the pathogenetic mechanism leading to microvascular alterations. In the macula-on cohort, mean change of axial length negatively correlated with mean change of SCP vessel density. This means that the greater the postoperative increase in axial length, the deeper the reduction of vessel density. A greater increase in axial length is secondary to a tighter encircling band. Scleral buckling procedure included an evacuative puncture with external fluid drainage in all cases. The encircling band is likely to be tighter in cases with a greater amount of subretinal fluid because post-drainage hypotony is usually dealt with by tightening the band. On this basis, our assumption is that a greater increase in axial length could be associated with a larger amount of subretinal fluid. Consequently, we might speculate that the larger the amount of subretinal fluid, the greater the impairment of SCP vessel density. This corroborates the hypothesis of vasoconstriction in the macular SCP secondary to an increase of vascular resistance due to peripheral hypoxia in the detached retina. However, we cannot rule out that this inverse correlation between axial length increase and vessel density change could be a consequence of mechanical damage of the retinal microvascular network caused by the surgery itself. D'Aloisio et al reported a reduction in iris perfusion on anterior segment OCTA after scleral buckling procedure.[7] The author speculated that these alterations could be related to mechanical stress on vessels due to surgical maneuvers and encircling band application.[7]

We found a reduction of vessel density in both superficial and deep capillary plexi in the macula-off group at 6 months after SB surgery. The deep capillary plexus has been shown to be more vulnerable to hypoxic injury.[14] Vascular alterations of this layer are typical of chronic diseases, such as diabetic retinopathy.[24] In the context of retinal detachment, a detached macula usually means a less recent onset compared with macula-on RRDs. The fact that DCP vessel density is reduced in the macula-off group could be secondary either to damage induced by the subretinal fluid or to microvascular alterations related to a longer disease duration. The increase of DCP vessel density during the follow-up might indicate that successful surgery removed the causative factor of such microvascular injury. However, the understanding of this mechanisms is limited by the lack of baseline scans.

Several limitations characterized the present study. First, the retrospective design might have introduced some bias. However, the strict eligibility criteria should have reduced this risk. Second, the sample size was relatively small. A larger population would have allowed additional analyses and to further investigate which clinical variables might have an influence on vessel density. Nonetheless, we included a total of 37 eyes and all surgeries were performed by the same vitreoretinal consultant. With regard to OCTA imaging, our software did not provide two different values of FAZ area for the deep and the superficial capillary plexi, but only one value including both layers.

In conclusion, our analyses showed that vessel density on OCTA is reduced following scleral buckling surgery for RRD. These microvascular alterations, to some extent, are similar to those reported after vitrectomy and could be a consequence of the disease rather than the surgical procedure. Axial length increase seems to be associated with worse vessel density outcome. Whether this is secondary to the presence of a greater amount of subretinal fluid at baseline or to mechanical damage caused by the encircling band needs to be further investigated. Larger studies are warranted to better understand which mechanisms lead to such a microvascular impairment and which clinical variables might have an influence on it.

Methods

This retrospective study was conducted at the Eye Clinic of the University of Catania, Italy. The study protocol was in agreement with the tenets of the Declaration of Helsinki and was approved by the Institutional Review Board (Comitato Etico Catania 1). Informed consent was obtained from all subjects. Medical charts of all consecutive patients who underwent scleral buckling surgery for primary RRD between September 2017 and December 2020 were reviewed.

For inclusion, the following criteria had to be satisfied: a) scleral buckling procedure as primary surgery for RRD in a phakic eye with healthy fellow eye; b) follow-up of 6 months or longer; c) anatomically reattached retina following single surgery with no evidence of intraoperative and postoperative complications; d) spectral domain-OCT (sd-OCT) and OCTA imaging at baseline and throughout the follow-up, namely at 1 month (± 7 days), 3-month (± 14 days) and 6-month (± 14 days) post-operatively; e) absence of abnormalities on sd-OCT imaging, such as intraretinal cysts, epiretinal membrane, intraretinal or subretinal spaces, external limiting membrane disruption, ellipsoid zone disruption, and retinal pigment epithelium alterations. Subjects with a history of ophthalmological diseases that could affect visual acuity and vascular density such as trauma, amblyopia, glaucoma, macular degeneration, macular hole, retinopathy of any type, uveitis, and pathological myopia (axial length > 26 mm) were excluded. Patients with a history of any prior intraocular surgery, except uncomplicated cataract, in either eye were also excluded. These exclusion criteria were applied to the fellow eye as well and patients with an anisometropia > 2.0 Diopters were excluded since the fellow eye was used as the control eye.

All SB surgeries were performed by the same vitreoretinal surgeon under retrobulbar anesthesia. Following a 360º conjunctival peritomy and rectus muscles isolation, all retinal tears were localized. A 2.4 mm encircling silicone band (Mira®, Mira Inc. Uxbridge, MA, USA) was placed under each rectus muscle. Segmental buckles were inserted underneath the silicone band to ensure retinal tear closure. Evacuative puncture and trans-scleral cryopexy were performed in all cases.

All patients received a complete eye examination at baseline and at each follow-up visit, including best corrected visual acuity (BCVA) measurement, slit-lamp examination, dilated fundus examination, and Goldmann tonometry. The BCVA was evaluated using the Early Treatment Diabetic Retinopathy charts and was converted into the logarithm of the minimum angle of resolution units (logMAR).

Axial length was measured preoperatively and 6-month post-operatively by using IOL Master device (Carl Zeiss Meditec, Dublin, CA, USA) in eyes with macula-on RRD, while an immersion ultrasound biometry (Quantel Compact Touch, Quantel Medical, TX, USA) was performed in eyes with macula-off RRD.

Spectral domain OCT and OCTA were performed by using the XR Avanti AngioVue System (Optovue Inc., Fremont, CA, USA). A 6x6 mm high-definition (400x400) Angio scan pattern, centered on the foveola, was carried out in both eyes at baseline and 1, 3 and 6 months postoperatively. This imaging is based on the split-spectrum amplitude decorrelation angiography (SSADA) method. AngioAnalytic software (Optovue, Inc., Fremont, CA, USA) automatically calculated the vessel density in the superficial capillary plexus (SCP) and deep capillary plexus (DCP) of the scanned area, providing these data for the whole image as well as for the foveal, parafoveal (3 mm) and perifoveal (6 mm) ETDRS sub-fields. Vessel density refers to the proportion of vessel area in the region of interest. Foveal avascular zone area was automatically analyzed. Central macular thickness (CMT) was recorded by the same OCT system. The inbuilt three-dimensional (3D) projection artifact removal (PAR) algorithm improved depth resolution of vascular layers and distinguished vascular plexus-specific features. The inbuilt software automatically evaluated scan quality and signal strength index (SSI). Two investigators (M.F. and A.L.) independently reviewed OCT and OCTA scans of eligible patients: patients with a scan quality < 6 and/or an SSI < 60 and/or residual motion artifacts were excluded. In cases of disagreement in the imaging review process, a third investigator (A.R.) was consulted. Scan segmentation was also checked and, when observed, errors were corrected using the inbuilt editing and propagation tools.

For each included patient, demographic characteristics, clinical and OCTA data were collected. Included patients were divided into two subgroups according to the preoperative status of the macula: the macula-on group and the macula-off group. The primary outcome was to assess changes in OCTA vessel density and FAZ area following SB surgery in the two groups. In the macula-on group, the change between preoperative and postoperative data of the RRD eye was analyzed, while in the macula-off group, given the lack of reliable baseline scans in the RRD eye, only postoperative change from month 1 to month 6 was analyzed. In both groups, these data were also compared with baseline data of the fellow eye, used as control. BCVA, CMT and axial length changes were considered as secondary outcomes in both groups. In the macula-on group, possible correlations between OCTA parameters (FAZ and VD) and change in BCVA and axial length were also investigated as secondary outcomes.

Statistical analysis

In two groups, values of each parameter detected at different time-points were compared by ANOVA; if significant, multiple comparison has been made by Tukey HSD test. The t-test was used to compare continuous variables between RRD eyes and control eyes. In the macula-on group, correlations were studied by applying the Pearson regression test. A P value < 0.05 was considered as significant. SPSS Statistics software version 21 (IBM Corp. Armonk, N.Y., USA) was used.

Declarations

Funding/Support: None

Financial Disclosures: No financial disclosures.

Competing interests: The authors declare no competing interests.

Other acknowledgments: We wish to thank the Scientific Bureau of the University of Catania for language support.

The datasets generated and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

References

1. Heimann, H. *et al.* Scleral Buckling versus Primary Vitrectomy in Rhegmatogenous Retinal Detachment. A Prospective Randomized Multicenter Clinical Study. Ophthalmology (2007) doi:10.1016/j.ophtha.2007.09.013.
2. Adelman, R. A., Parnes, A. J. & Ducournau, D. Strategy for the management of uncomplicated retinal detachments: The european vitreo-retinal society retinal detachment study report 1. in *Ophthalmology* (2013). doi:10.1016/j.ophtha.2013.01.070.
3. Wang, A. & Snead, M. P. Scleral buckling—a brief historical overview and current indications. Graefe's Archive for Clinical and Experimental Ophthalmology (2020) doi:10.1007/s00417-019-04562-1.
4. Fallico, M. *et al.* Scleral Buckling: A Review of Clinical Aspects and Current Concepts. *J. Clin. Med. 2022, Vol. 11, Page 314* **11**, 314 (2022).

5. Lee, D. H. *et al.* Long-term Effect of Scleral Encircling on Axial Elongation. Am. J. Ophthalmol. **189**, 139–145 (2018).
6. Eshita, T. *et al.* Retinal blood flow in the macular area before and after scleral buckling procedures for rhegmatogenous retinal detachment without macular involvement. Jpn. J. Ophthalmol. **48**, 358–363 (2004).
7. D'Aloisio, R. *et al.* Changes in Iris Perfusion Following Scleral Buckle Surgery for Rhegmatogenous Retinal Detachment: An Anterior Segment Optical Coherence Tomography Angiography (AS-OCTA) Study. J. Clin. Med. **9**, 1231 (2020).
8. Cennamo, G. *et al.* Optical coherence tomography angiography features in post COVID-19 pneumonia patients: a pilot study. Am. J. Ophthalmol. (2021) doi:10.1016/j.ajo.2021.03.015.
9. Christou, E. E., Stavrakas, P., Batsos, G., Christodoulou, E. & Stefaniotou, M. Association of OCT-A characteristics with postoperative visual acuity after rhegmatogenous retinal detachment surgery: a review of the literature. Int. Ophthalmol. **41**, 2283–2292 (2021).
10. Barca, F. *et al.* OCT Angiography Findings in Macula-ON and Macula-OFF Rhegmatogenous Retinal Detachment: A Prospective Study. J. Clin. Med. **9**, 3982 (2020).
11. Tsen, C. L., Sheu, S. J., Chen, S. C. & Wu, T. T. Imaging analysis with optical coherence tomography angiography after primary repair of macula-off rhegmatogenous retinal detachment. Graefe's Arch. Clin. Exp. Ophthalmol. **257**, 1847–1855 (2019).
12. Woo, J. M., Yoon, Y. S., Woo, J. E. & Min, J. K. Foveal Avascular Zone Area Changes Analyzed Using OCT Angiography after Successful Rhegmatogenous Retinal Detachment Repair. Curr. Eye Res. **43**, 674–678 (2018).
13. Nam, S. H., Kim, K., Kim, E. S., Kim, D. G. & Yu, S. Y. Longitudinal Microvascular Changes on Optical Coherence Tomographic Angiography after Macula-Off Rhegmatogenous Retinal Detachment Repair Surgery. Ophthalmologica **244**, 34–41 (2021).
14. Bonfiglio, V. *et al.* Vascular changes after vitrectomy for rhegmatogenous retinal detachment: optical coherence tomography angiography study. Acta Ophthalmol. **98**, e563–e569 (2020).
15. Hong, E. H. *et al.* Changes in retinal vessel and retinal layer thickness after vitrectomy in retinal detachment via swept-source OCT angiography. Investig. Ophthalmol. Vis. Sci. **61**, (2020).
16. Matthew Mckay, K. *et al.* Retinal microvasculature changes after repair of macula-off retinal detachment assessed with optical coherence tomography angiography. Clin. Ophthalmol. **14**, 1759–1767 (2020).
17. Wang, H., Xu, X., Sun, X., Ma, T. & Sun, T. Macular perfusion changes assessed with optical coherence tomography angiography after vitrectomy for rhegmatogenous retinal detachment. Graefes Arch. Clin. Exp. Ophthalmol. **257**, 733–740 (2019).
18. Sato, E., Shinoda, K., Kimura, I., Ohtake, Y. & Inoue, M. Microcirculation in eyes after rhegmatogenous retinal detachment surgery. Curr. Eye Res. **32**, 773–779 (2007).
19. Cardillo Piccolino, F. Vascular changes in rhegmatogenous retinal detachment. Ophthalmologica. **186**, 17–24 (1983).

20. Quintyn, J. & Brasseur, G. Subretinal fluid in primary rhegmatogenous retinal detachment: physiopathology and composition. Surv. Ophthalmol. **49**, 96–108 (2004).

21. Delolme, M. P. *et al.* Anatomical and functional macular changes after rhegmatogenous retinal detachment with macula off. Am. J. Ophthalmol. **153**, 128–136 (2012).

22. Bonfiglio, V. *et al.* Intravitreal dexamethasone implant for cystoid macular edema and inflammation after scleral buckling. Eur. J. Ophthalmol. **25**, e98–e100 (2015).

23. Agarwal, A. *et al.* FRACTAL DIMENSION AND OPTICAL COHERENCE TOMOGRAPHY ANGIOGRAPHY FEATURES OF THE CENTRAL MACULA AFTER REPAIR OF RHEGMATOGENOUS RETINAL DETACHMENTS. Retina **39**, 2167–2177 (2019).

24. Dimitrova, G. & Chihara, E. Implication of Deep-Vascular-Layer Alteration Detected by Optical Coherence Tomography Angiography for the Pathogenesis of Diabetic Retinopathy. Ophthalmologica. **241**, 179–182 (2019).

Figures

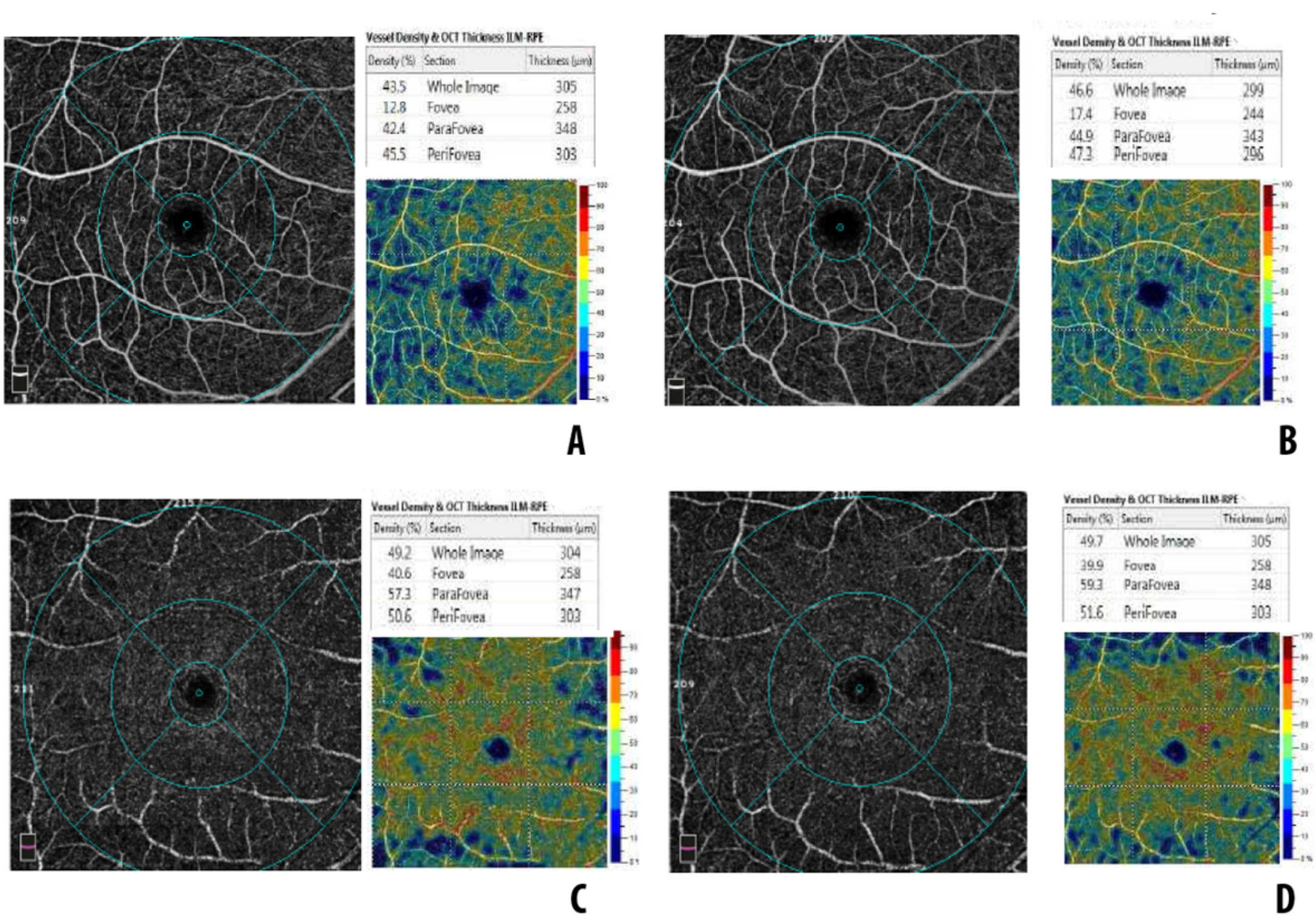

Figure 1

OCTA imaging in a case of macula-on retinal detachment: A, baseline superficial capillary plexus; B, superficial capillary plexus at 6 months postoperatively; C baseline deep capillary plexus; D, deep capillary plexus at 6 months postoperatively.

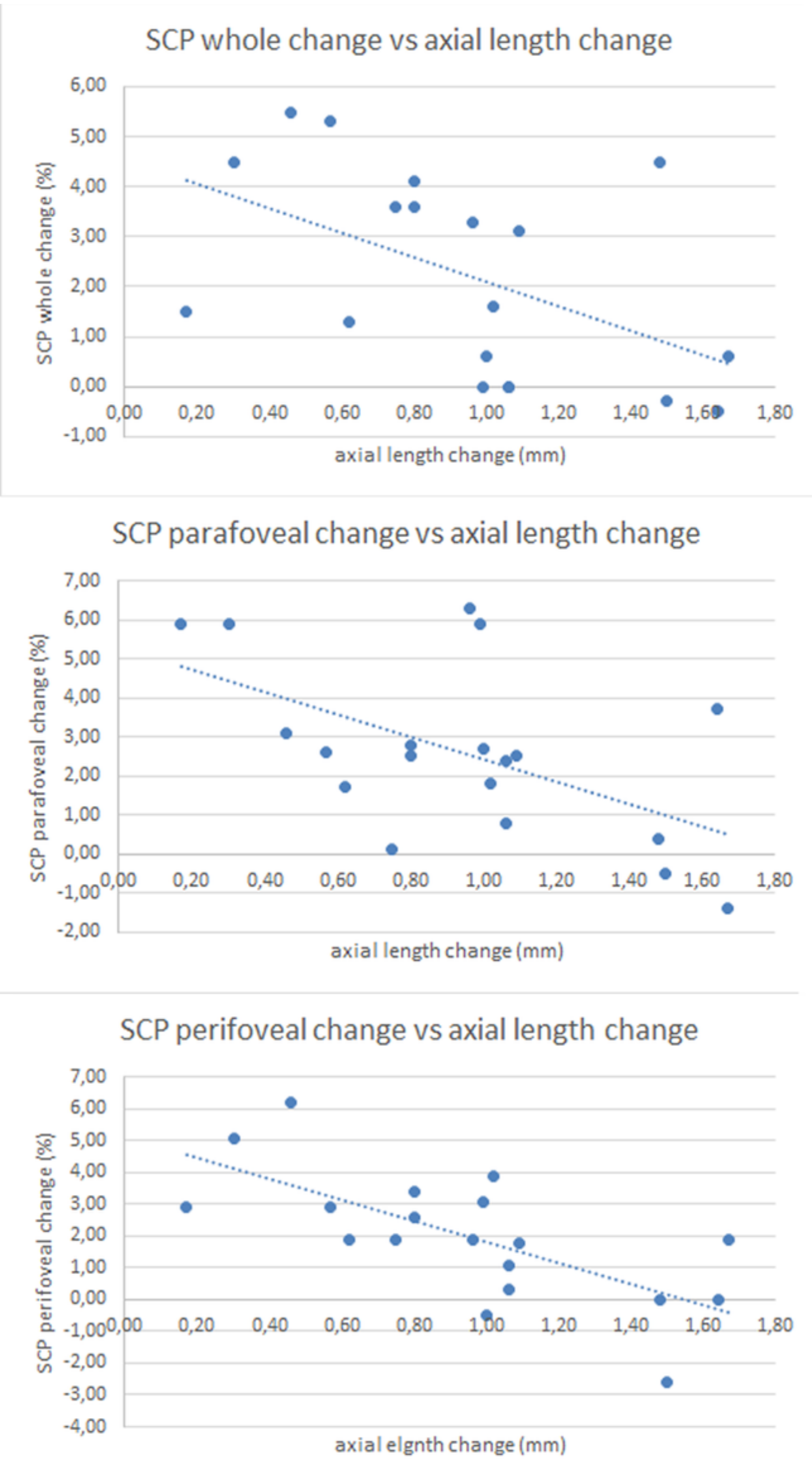

Figure 2

Scatterplots illustrating correlation analysis in the macula-on group between axial length change and vessel density change in the whole, parafoveal and perifoveal superficial capillary plexi (SCP).

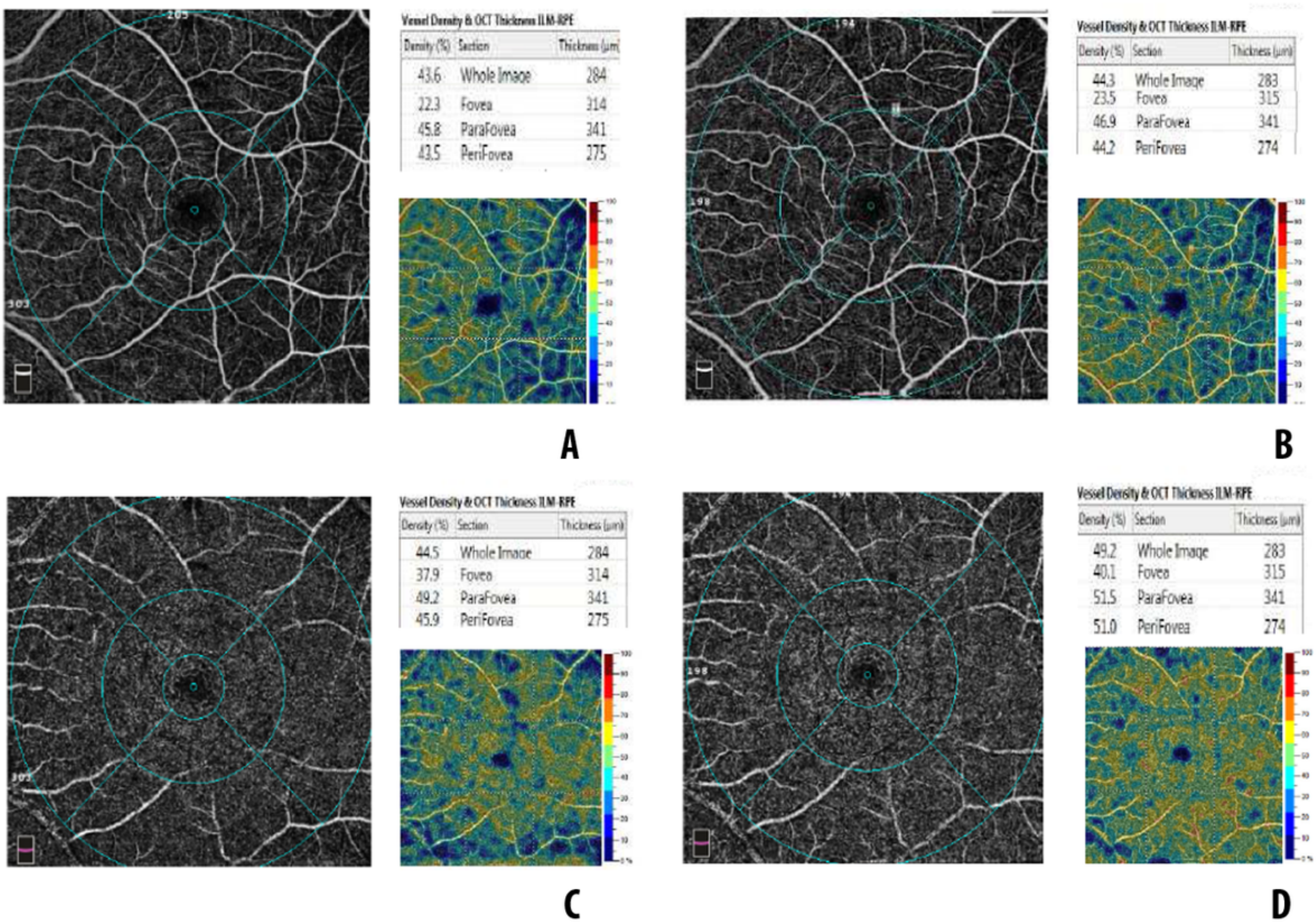

Figure 3

OCTA imaging in a case of macula-off retinal detachment: A, superficial capillary plexus at 1 month postoperatively; B, superficial capillary plexus at 6 months postoperatively; C deep capillary plexus at 1 month postoperatively; D, deep capillary plexus at 6 months postoperatively.