Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Subfoveal Choroidal Thickness After Combined Pars Plana Vitrectomy and 360° Encircling Scleral Buckling for Primary Rhegmatogenous Retinal Detachment: A Descriptive Swept-Source OCT Analysis

Francisco Calleja-Casado

franciscocallejacasado@gmail.com

Hospital Clínico Universitario de Valencia

Noemí Ruiz del Río

University of Valencia

Manal Afghani

University of Valencia

Sergio Obiol Ferrando

Hospital Clínico Universitario de Valencia

Research Article

Keywords: rhegmatogenous retinal detachment, pars plana vitrectomy, scleral buckling, subfoveal choroidal thickness, swept-source optical coherence tomography

Posted Date: August 13th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10435738/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Purpose: To describe postoperative subfoveal choroidal thickness (SFCT) after combined pars plana vitrectomy (PPV) and 360° encircling scleral buckling (SB) for primary rhegmatogenous retinal detachment (RRD), using swept-source optical coherence tomography (SS-OCT), and to report the associated anatomical and visual outcomes.

Design: Retrospective, observational case series at a tertiary referral center.

Participants: Thirty-two eyes of 32 consecutive patients undergoing combined PPV and 360° encircling SB as primary repair for RRD between January 2020 and December 2023.

Methods: All eyes were treated with a standardized combined technique. SS-OCT (DRI-OCT Triton) was performed at approximately 1 month and 3–6 months postoperatively. SFCT was measured manually at the foveal center and compared with unoperated fellow eyes. Best-corrected visual acuity (BCVA), residual subfoveal subretinal fluid (SRF), and ellipsoid zone integrity were also assessed.

Main Outcome Measures: Postoperative SFCT in operated versus fellow eyes, single-operation and final anatomical success, and change in BCVA.

Results: Single-operation reattachment was 100% at 1 month; one eye developed recurrent RRD, yielding a true single-operation success rate of 97% (31/32) and 100% final anatomical success. Mean BCVA improved from logMAR 1.0 to 0.3 ($P < .001$), with better outcomes in macula-on than macula-off eyes (logMAR 0.1 vs 0.4; $P = .02$). Residual subfoveal SRF was present in 10 eyes (31%) at 1 month and resolved in 8 by 3–6 months. Mean 1-month SFCT was 235 ± 60 μm in operated eyes versus 220 ± 55 μm in fellow eyes, a nonsignificant difference ($P = .18$); given the sample size, the study was likely underpowered to detect a difference of this magnitude. Eyes with persistent SRF showed a nonsignificant trend toward greater SFCT (~260 vs ~225 μm). By final follow-up, SFCT in operated eyes decreased to approximately 225 μm, approaching fellow-eye values. No choroidal detachment or buckle-related complications occurred.

Conclusions: Combined PPV with a 360° encircling scleral buckle was a highly effective repair for primary RRD, with excellent single-operation success and favorable visual recovery. On descriptive SS-OCT analysis, the combined technique was not associated with a sustained increase in subfoveal choroidal thickness. Given the absence of a control group and the limited sample, these findings are hypothesis-generating and warrant confirmation in larger prospective studies.

Introduction

Rhegmatogenous retinal detachment (RRD) is a vision-threatening condition historically managed with scleral buckling (SB), in which an exoplant is sutured to the sclera to indent the eye wall and support retinal breaks. Pars plana vitrectomy (PPV) relieves vitreoretinal traction directly and uses internal tamponade to reattach the retina. Over the past two decades practice has shifted toward primary PPV

for many cases, particularly in older or pseudophakic eyes, although the optimal approach remains debated.[1,2]

In the Scleral buckling versus primary vitrectomy trial, SB provided superior visual outcomes in phakic eyes with medium-complexity RRD, whereas in pseudophakic eyes PPV achieved a higher single-operation reattachment rate.[1] A meta-analysis of 15,661 eyes confirmed comparable final anatomical success between PPV alone and combined PPV with SB, while the combined approach yielded a higher single-operation success rate, particularly in phakic eyes.[2] Adding an encircling buckle nonetheless introduces refractive change, discomfort, and potential local complications, so surgical decision-making requires balancing these trade-offs for each case.[3,4]

Swept-source optical coherence tomography (SS-OCT) has improved characterization of postoperative retinal and choroidal changes after RRD repair, allowing detailed assessment of residual subretinal fluid (SRF), outer retinal recovery, and choroidal morphology. Persistent subfoveal SRF is common after successful repair and tends to resolve more slowly after SB than after PPV.[5,6] Several studies of SB without vitrectomy have reported postoperative increases in subfoveal choroidal thickness (SFCT) or choroidal vascular congestion, implicating choroidal alterations in delayed SRF resorption.[7–11] A thicker choroid has likewise been associated with delayed subretinal fluid absorption after RRD surgery.[12]

Data specifically addressing choroidal behavior after combined PPV and encircling SB remain limited.[13] Mechanistically, encircling buckles have been proposed to alter choroidal venous outflow by modifying scleral contour and vortex vein dynamics, potentially producing transient choroidal congestion.[14] Whether the simultaneous addition of vitrectomy modifies these dynamics is unknown. In this context, we describe postoperative SFCT after combined PPV and 360° encircling SB for primary RRD using SS-OCT, comparing operated with fellow eyes at defined postoperative time points. Because no standalone SB or standalone PPV control group was available, the study is descriptive and no causal inference regarding the differential effect of each surgical component is intended.

Methods

Study Design and Participants

This retrospective, observational case series was conducted at a tertiary referral center and followed the tenets of the Declaration of Helsinki. The institutional review board approved the study and informed consent was obtained. Reporting adheres to the STROBE guidance for observational studies. All consecutive patients undergoing surgery for primary RRD between January 2020 and December 2023 were reviewed. Eligible eyes were those treated with combined PPV and a 360° circumferential scleral buckle as the initial repair. The combined approach was selected when the operating surgeon judged the case to carry higher risk for proliferative vitreoretinopathy (PVR) or to require additional vitreous base support (eg, inferior retinal breaks, extensive lattice degeneration, or young phakic status).

Exclusion criteria were previous retinal detachment surgery, traumatic RRD, PVR grade C or higher, giant retinal tears, and secondary causes of detachment. Unoperated fellow eyes were used only for OCT comparison and were not included in outcome analyses.

Surgical Technique

Procedures were performed under peribulbar anesthesia by three fellowship-trained vitreoretinal surgeons following a standardized protocol. A 360° encircling silicone band (2.5 mm) was passed beneath the rectus muscles and tightened to moderate indentation, targeting a buckle height of approximately 1.0 mm; segmental elements were added selectively for large anterior breaks or dialysis. A standard three-port PPV (23- or 25-gauge) was then performed, with induction of posterior vitreous detachment when absent, meticulous vitreous base shaving with scleral depression, and endolaser to all breaks. Fluid–air exchange was performed through the primary break or a drainage retinotomy. Internal tamponade was sulfur hexafluoride (SF6) gas in most eyes or silicone oil (1000 cSt) in higher-risk eyes. Postoperative positioning followed break location, and all eyes received standard topical corticosteroid and antibiotic therapy.

Data Collection and Imaging

Recorded variables included age, sex, lens status, detachment extent, break location, macular status, and PVR grade. Best-corrected visual acuity (BCVA) was recorded preoperatively and at final follow-up. Single-operation anatomical success was defined as complete reattachment without additional retinal surgery; final anatomical success as attachment after all required procedures. Postoperative SS-OCT (DRI-OCT Triton; Topcon, Tokyo, Japan) was performed at approximately 1 month and 3–6 months. Subfoveal SRF, outer retinal integrity including ellipsoid zone continuity, and SFCT were assessed. SFCT was measured manually as the perpendicular distance from the outer border of the retinal pigment epithelium to the choroid–sclera interface at the foveal center and compared with fellow eyes when available as shown in Figs. 1 and 2.

Preoperative SS-OCT was obtained in all patients; however, reliable preoperative SFCT was not measurable in all cases, particularly in macula-off detachments and highly myopic eyes, owing to poor delineation of the choroid–sclera interface (Supplementary Figs. 1 and 2).

Statistical Analysis

Visual acuity was converted to logMAR. Preoperative and postoperative BCVA were compared using paired t tests. Between-group comparisons used independent t tests or Mann–Whitney U tests according to distribution assessed by the Shapiro–Wilk test. Differences in SFCT between operated and fellow eyes, and between eyes with and without postoperative SRF, were analyzed with appropriate parametric or nonparametric tests. Categorical variables were compared using chi-square or Fisher

exact tests. A two-sided P value < .05 was considered statistically significant. Analyses were performed in SPSS version 27.0 (IBM, Armonk, NY).

Results

Patient Characteristics

Thirty-two eyes of 32 patients met inclusion criteria. Mean age was 58.4 ± 12.7 years (range, 32–77). Fourteen patients (44%) were phakic and 18 (56%) pseudophakic. The macula was detached in 20 eyes (63%) and attached in 12 (37%). Breaks were superior in 19 eyes (59%), inferior in 7 (22%), and in both locations in 6 (19%). All eyes received a 360° encircling band, and 5 (16%) required an additional radial sponge for anterior dialysis (Table 1). No intraoperative buckle-related complications occurred. Perfluorocarbon liquid was used transiently in 3 eyes (9%). Tamponade was SF6 gas in 27 eyes (84%) and silicone oil in 5 (16%).

Table 1
Baseline Characteristics and OCT Findings of Eyes Undergoing Combined Vitrectomy and 360° Scleral Buckle

Variable	Value
Eyes, No.	32
Age, y, mean ± SD	58.4 ± 12.7
Lens status	Phakic 44%; pseudophakic 56%
Macular status	Macula-off 63%; macula-on 37%
Break location	Superior 59%; inferior 22%; both 19%
Tamponade	SF6 84%; silicone oil 16%
Residual SRF at 1 month	31%
Residual SRF at final visit	6%
SFCT, operated eye, μm	235 ± 60
SFCT, fellow eye, μm	220 ± 55

Abbreviations: OCT, optical coherence tomography; SD, standard deviation; SF6, sulfur hexafluoride; SFCT, subfoveal choroidal thickness; SRF, subretinal fluid.

Anatomical and Visual Outcomes

Single-operation reattachment was 100% (32/32) at 1 month; one eye subsequently developed recurrent RRD from new peripheral breaks and required revision vitrectomy, yielding a true single-operation success rate of 97% (31/32) at final follow-up (mean, 8.5 months). Final anatomical success was 100% after reoperation, and no eye failed because of PVR. Overall mean BCVA improved from logMAR 1.0 (~ 20/200) to 0.3 (~ 20/40; P < .001). Final BCVA was better in macula-on eyes (logMAR 0.1 ≈ 20/25) than in macula-off eyes (logMAR 0.4 ≈ 20/50; P = .02). Among phakic patients, 9 of 14 (64%) showed cataract progression and 5 (36%) underwent cataract surgery during follow-up, with subsequent visual improvement. No patient experienced irreversible vision loss from surgical complications.

OCT Findings

At 1 month, SS-OCT revealed residual subfoveal SRF in 10 of 32 eyes (31%); in all cases the fluid was shallow and confined to the fovea. By 3–6 months, SRF had resolved in 8 of these eyes, while 2 (6%) showed trace persistent SRF at final follow-up. Persistent SRF was not associated with poorer visual outcome; one eye with residual SRF reached 20/30. Mean 1-month SFCT was 235 ± 60 μm in operated eyes versus 220 ± 55 μm in fellow eyes, a difference that did not reach statistical significance (P = .18). Given the sample of 32 eyes, the study is likely underpowered to detect a difference of this magnitude (~ 15 μm); the absence of significance therefore cannot be interpreted as evidence of equivalence (potential type II error). Eyes with persistent SRF showed a nonsignificant trend toward greater SFCT (~ 260 μm) than eyes without SRF (~ 225 μm). By final follow-up, mean SFCT in operated eyes decreased to approximately 225 μm, approaching fellow-eye values (Figs. 1 and 2).

Qualitative outer retinal recovery progressed over time. Ellipsoid zone disruption was present in 18 of 20 macula-off eyes (90%) at 1 month and improved to 15 of 20 (75%) by 6 months; persistent disruption was associated with longer detachment duration or greater extent and more limited visual recovery. Wide-field imaging showed mild peripheral indentation corresponding to the encircling buckle without compromising visualization of the periphery. No eye developed choroidal detachment. Two patients had transient ocular hypertension (~ 30 mm Hg), controlled medically without progression to glaucoma.

Complications

Aside from the single redetachment and transient intraocular pressure elevations, complications were minimal. No clinically significant epiretinal membrane developed. One eye had mild cystoid macular edema at 1 month that resolved with topical nonsteroidal anti-inflammatory therapy. No buckle extrusion or infection occurred, and three patients reported transient diplopia in extreme gaze that resolved spontaneously.

Discussion

Combined PPV with a 360° encircling scleral buckle achieved excellent anatomical and functional outcomes in this series of primary RRD, with single-operation reattachment in 97% of eyes and 100%

final anatomical success. Visual outcomes were determined largely by macular status at presentation, as expected. Although no vitrectomy-only control group was included, the primary success rate exceeds rates commonly reported for vitrectomy alone (typically 85%–90% depending on complexity), consistent with evidence that combined repair increases single-operation success, particularly in phakic eyes.[2] The encircling band likely provided additional vitreous-base support in eyes with inferior pathology or extensive lattice degeneration; the single recurrence occurred in an eye with extensive lattice, underscoring that PVR-related forces may still develop despite adequate peripheral support.

Approximately one-third of eyes exhibited residual subfoveal SRF at 1 month, consistent with prior reports after RRD repair.[5,6] Despite internal drainage as part of the combined approach, transient SRF was still observed, suggesting a physiological postoperative phenomenon rather than incomplete reattachment. Importantly, SRF resolved in nearly all cases by 3–6 months and did not adversely affect final acuity.[5]

Choroidal behavior after RRD repair has received increasing attention. Several studies report increased SFCT after scleral buckling performed without vitrectomy, suggesting postoperative choroidal congestion,[7–11] and a thicker choroid has been linked to delayed subretinal fluid absorption.[12] A recent analysis likewise found that scleral buckling leads to increased SFCT through choroidal compression, whereas persisting SRF after PPV was not influenced by SFCT.[6] In the present combined cohort, however, we did not observe a sustained increase in SFCT: values in operated eyes approached those of fellow eyes over time. Eyes with persistent SRF tended to have thicker choroids, but this trend did not reach significance. Because the series lacks standalone SB or PPV control groups, it is not possible to attribute this pattern to the addition of vitrectomy or to determine whether choroidal behavior differs from that after SB alone. The descriptive observation of stable postoperative SFCT in this combined setting is nonetheless of interest and warrants controlled evaluation.

Encircling buckles may transiently alter vortex vein outflow and produce mild choroidal venous congestion, as proposed in imaging-based models of acquired venous overload choroidopathy.[14] That we observed no sustained thickening may reflect an attenuating effect of concurrent vitrectomy, a genuinely modest choroidal response in this cohort, or insufficient power to detect a small difference. These possibilities are hypothesis-generating and should be tested directly in larger, controlled studies incorporating standardized preoperative imaging and choroidal vascularity metrics.

This study has limitations, including its retrospective design, small sample, and absence of both standalone SB and standalone PPV control arms, which preclude causal attribution of the choroidal findings to any single surgical component. The cohort is heterogeneous in lens status and tamponade type; silicone oil, present in 16% of eyes, can influence OCT optical path length and may independently affect choroidal measurements, and no multivariable adjustment was performed for these variables. Reliable preoperative SFCT was not obtainable in all eyes, so the analysis focuses on postoperative behavior rather than absolute pre–post change. Finally, follow-up may be insufficient to capture rare late buckle-related events. These constraints underscore the exploratory nature of the work.

Conclusion

Combined PPV with an encircling scleral buckle was a highly effective repair for primary RRD, with excellent single-operation success and favorable visual recovery. On descriptive SS-OCT analysis, the combined technique was not associated with a sustained increase in subfoveal choroidal thickness. Given the absence of a control group and the limited sample, these observations are hypothesis-generating and should be confirmed in larger prospective studies with appropriate control arms.

Declarations

Financial Support: The authors received no financial support for the research, authorship, or publication of this article.

Conflict of Interest: The authors have no relevant financial or non-financial relationships to disclose.

Ethics Approval: The study adhered to the tenets of the Declaration of Helsinki and was approved by the Institutional Ethics Committee of the Hospital Clínico Universitario de Valencia. Informed consent was obtained; retrospective review was approved by the committee.

Meeting Presentation: None.

Data Availability: The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Use of AI-Assisted Technology: A large language model (Claude) was used solely for language editing and grammar refinement of author-written text. No AI tool was used for study design, data collection, analysis, interpretation, or figure generation. The authors take full responsibility for the content and integrity of the manuscript.

References

1. Heimann H, Bartz-Schmidt KU, Bornfeld N, et al. Scleral buckling versus primary vitrectomy in rhegmatogenous retinal detachment: a prospective randomized multicenter clinical study. Ophthalmology. 2007;114(12):2142–2154.
2. Eshtiaghi A, Dhoot AS, Mihalache A, et al. Pars plana vitrectomy with and without supplemental scleral buckle for the repair of rhegmatogenous retinal detachment: a meta-analysis. Ophthalmol Retina. 2022;6(10):871–885.
3. Fallico M, Russo A, Longo A, et al. Scleral buckling: a review of clinical aspects and current concepts. J Clin Med. 2022;11(2):314.
4. Zajner C, Leung B, Sheidow T, Malvankar-Mehta MS. Quality of life after pars plana vitrectomy, scleral buckle, or pneumatic retinopexy for rhegmatogenous retinal detachment: a meta-analysis. Curr Eye Res. 2024;49(3):295–302.

5. Benson SE, Schlottmann PG, Bunce C, Xing W, Charteris DG. Foveal reattachment after macula-off retinal detachment: timing of surgery and visual outcome. Ophthalmology. 2006;113(4):769–774.
6. Mansour AM, Parodi MB, Uwaydat SH, et al. Subfoveal choroidal thickness after successful retinal detachment repair with persistent subretinal fluid at the macula. Clin Ophthalmol. 2025;19:1847–1854.
7. Kimura S, Morizane Y, Hosokawa M, et al. Subfoveal choroidal thickness change following segmental scleral buckling for rhegmatogenous retinal detachment. Am J Ophthalmol. 2012;153(4):689–695.
8. Odrobina D, Michalewska Z, Michalewski J, Dzięgielewski K, Nawrocki J. Influence of scleral buckling surgery with encircling band on choroidal thickness. Ophthalmologica. 2013;229(4):215–220.
9. Akkoyun I, Yilmaz G, Erdurman C, et al. Choroidal thickness after scleral buckling surgery. Retina. 2014;34(4):667–671.
10. Montezuma SR, Leite EB, Arantes TE, et al. Effect of scleral buckling surgery on choroidal thickness measured by enhanced depth imaging optical coherence tomography. PLoS One. 2016;11(3):e0151101.
11. Bernabei F, Sodi A, Menchini M, et al. Choroidal vascular changes after encircling scleral buckle surgery. Retina. 2021;41(5):1021–1029.
12. Choroidal thickness is associated with delayed subretinal fluid absorption after rhegmatogenous retinal detachment surgery. Ophthalmol Retina. 2019;3(8):655–662.
13. Gama AR, Farah ME, Maia M, et al. Macular choroidal thickness after vitreoretinal surgery with or without scleral buckle for primary rhegmatogenous retinal detachment. Retina. 2017;37(3):456–462.
14. Carlà MM, Couturier A, Mottola F, et al. The influence of scleral buckle on choroidal architecture: an unexplored link with the spectrum of acquired venous overload choroidopathy. Surv Ophthalmol. 2025;70(6):1181–1190.

Figures

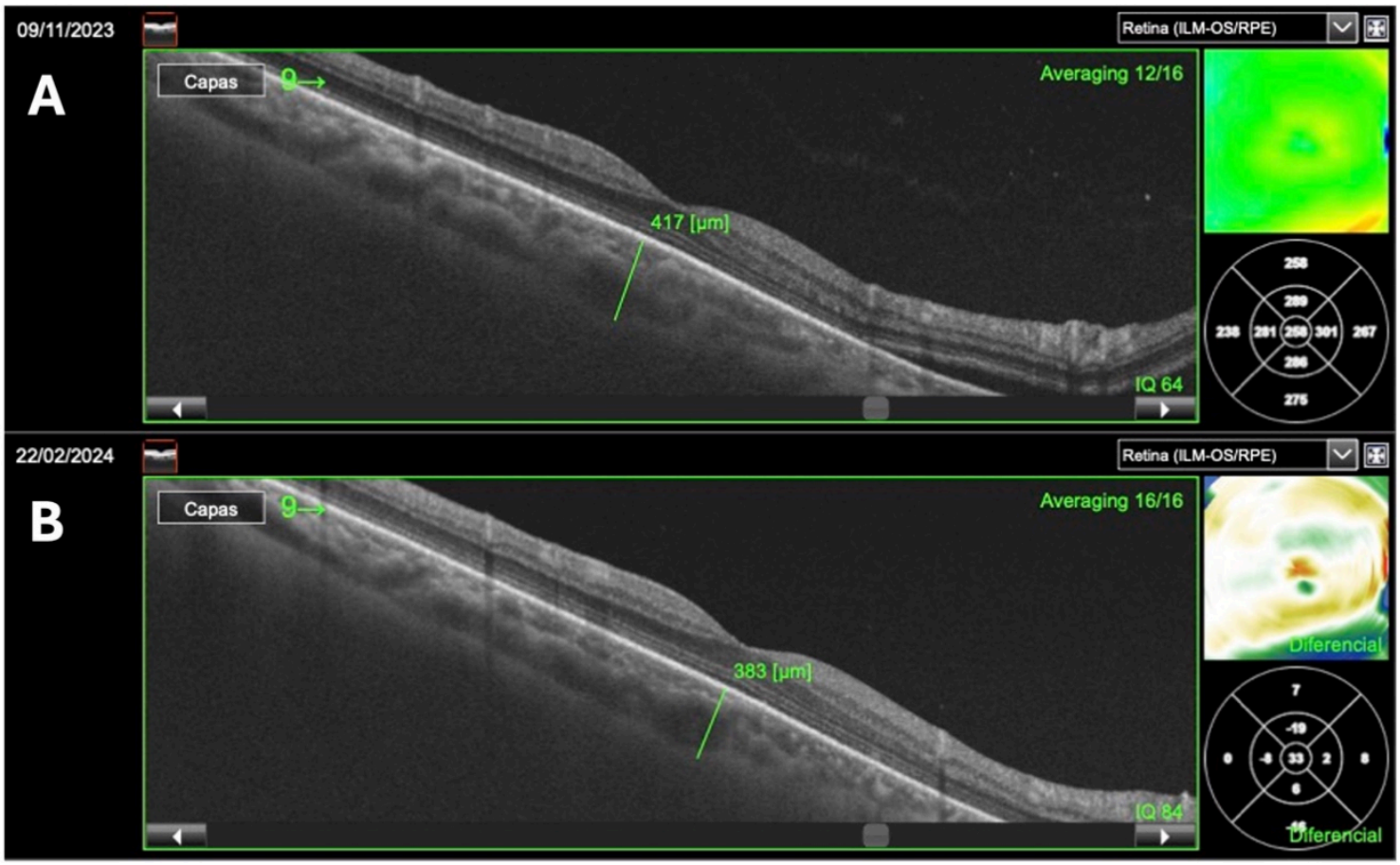


Figure 1

Swept-source optical coherence tomography (SS-OCT) images showing subfoveal choroidal thickness (SFCT) measurement. (A) Preoperative horizontal B-scan through the foveal center. (B) Postoperative B-scan of the same eye after combined pars plana vitrectomy and 360° encircling scleral buckling. SFCT was measured manually as the perpendicular distance from the outer border of the retinal pigment epithelium to the choroid–sclera interface at the foveal center (green caliper).

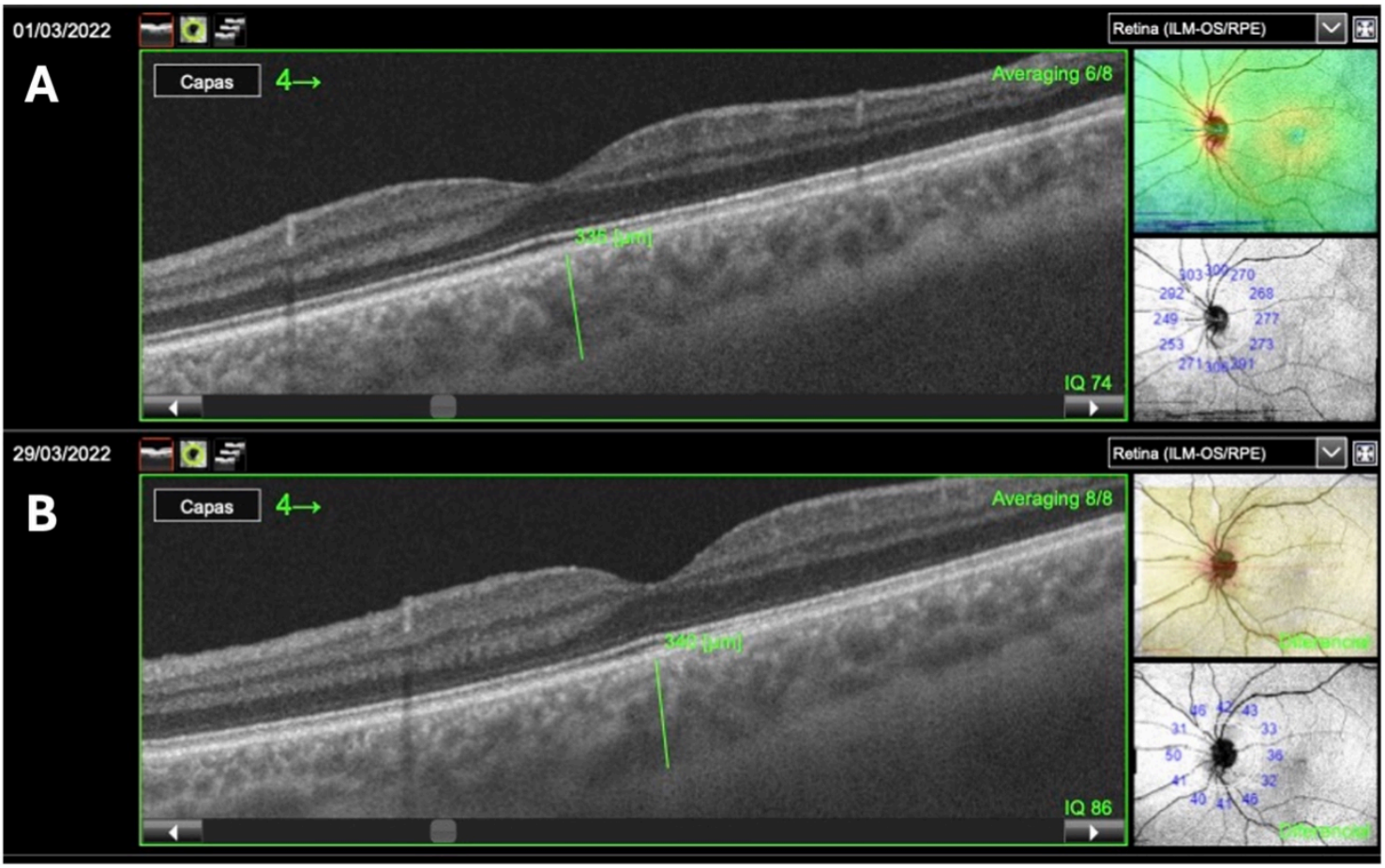


Figure 2

SS-OCT images illustrating SFCT measurement in a representative eye. (A) Early postoperative horizontal B-scan. (B) Follow-up B-scan of the same eye, showing stable SFCT over time. SFCT was measured as in Figure 1 (green caliper).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SUPPLEMENTARYFILE.docx