

Twenty-five-gauge endoillumination-assisted scleral buckling for rhegmatogenous retinal detachment: a prospective observational study of clinical outcomes and macular OCT angiography

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Research Article

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Abstract

Background

Conventional scleral buckling remains an important option for selected phakic patients with rhegmatogenous retinal detachment (RRD), but visualization through binocular indirect ophthalmoscopy may be limited during peripheral break localization and cryopexy. This study evaluated whether 25-gauge (25G) endoillumination-assisted scleral buckling improves early clinical outcomes without adversely affecting macular microcirculation.

Methods

This prospective observational study included 64 eyes of 64 patients aged 18–50 years with RRD. Thirty-two eyes underwent conventional scleral buckling and 32 underwent 25G endoillumination-assisted scleral buckling. Best-corrected visual acuity (BCVA; logMAR), intraocular pressure, axial length, anterior segment parameters, retinal reattachment, complications, and optical coherence tomography angiography (OCTA) parameters were assessed preoperatively and at 2, 4, and 12 weeks after surgery. Longitudinal outcomes were analyzed using repeated-measures analysis of variance or linear mixed models; categorical variables were compared using the chi-square test or Fisher exact test.

Results

Baseline characteristics were balanced between groups. The primary retinal reattachment rate was 93.8% in the conventional group and 96.9% in the 25G-assisted group ($P = 1.000$); final reattachment was achieved in all eyes. BCVA showed significant time and group effects (time effect: $F = 21.479$, $P < 0.001$; group effect: $F = 12.119$, $P = 0.043$). At 2 weeks, BCVA was better in the 25G-assisted group than in the conventional group (0.36 ± 0.14 vs 0.55 ± 0.13 logMAR, $P < 0.001$), whereas between-group differences at 4 and 12 weeks were not significant. Superficial and deep capillary plexus vessel densities increased slightly after reattachment in both groups, with no significant group effect or group-by-time interaction. Macular ganglion cell complex thickness remained stable. Five eyes (15.6%) in the 25G-assisted group showed transient vitreous disturbance or fiber tracks; no endophthalmitis, choroidal hemorrhage, retinal incarceration, or other severe adverse event was observed.

Conclusions

In selected young phakic patients with RRD, 25G endoillumination-assisted scleral buckling improved intraoperative visualization and was associated with faster early visual recovery. Under controlled low-illumination conditions and limited intraocular manipulation, this approach did not show detectable short-term adverse effects on macular OCTA parameters or mGCC thickness.

Trial registration:

Not applicable.

Background

Rhegmatogenous retinal detachment (RRD) is a vision-threatening vitreoretinal disease in which liquefied vitreous enters the subretinal space through a retinal break. Although pars plana vitrectomy (PPV) has become increasingly common with the development of wide-angle viewing systems, small-gauge instrumentation, and improved vitreous cutters, scleral buckling remains a valuable procedure in carefully selected patients. This is particularly true for younger phakic patients with limited detachment, anterior breaks, and mild proliferative vitreoretinopathy (PVR), in whom induction of posterior vitreous detachment during PPV may increase the risk of iatrogenic breaks, lens injury, and postoperative intraocular pressure fluctuations [4].

The main limitation of conventional scleral buckling is not the concept of the operation itself but the way in which it is visualized. Binocular indirect ophthalmoscopy provides a broad field, but the inverted image, limited magnification, and dependence on media clarity can make small peripheral retinal breaks or lattice degeneration difficult to assess. Chandelier illumination, microscope-assisted ab externo surgery, three-dimensional visualization, and other endoillumination-based approaches have therefore been introduced to improve peripheral retinal visualization during scleral buckling [8–10, 13].

Anatomic reattachment does not fully explain postoperative visual recovery. Macular superficial capillary plexus (SCP) and deep capillary plexus (DCP) vessel density, choriocapillaris perfusion, outer retinal integrity, and ellipsoid zone recovery have all been associated with postoperative visual function after RRD repair [2–4]. Optical coherence tomography angiography (OCTA) provides a non-invasive means of assessing retinal microcirculation, but its quantitative measurements are influenced by scan size, segmentation boundaries, image quality, projection artifacts, and fixation stability. For this reason, OCTA studies require clear reporting of acquisition and quality-control procedures.

This study was designed to evaluate the clinical efficacy and short-term safety of 25G endoillumination-assisted scleral buckling in patients with RRD who were suitable for an ab externo approach. In addition to retinal reattachment and BCVA, we assessed longitudinal changes in SCP and DCP vessel density and macular ganglion cell complex (mGCC) thickness to determine whether a single 25G endoillumination channel produced measurable adverse effects on macular microcirculation.

Methods

Study design and participants

This was a prospective observational clinical study conducted at the Department of Ophthalmology, The Second Affiliated Hospital of Zunyi Medical University. Patients with RRD who met the eligibility criteria

between March 2020 and March 2024 were enrolled. Sixty-four eyes of 64 patients aged 18–50 years were included. According to the surgical procedure performed, 32 eyes were included in the conventional scleral buckling group and 32 eyes in the 25G endoillumination-assisted scleral buckling group.

The study adhered to the tenets of the Declaration of Helsinki and was approved by the Ethics Committee of The Second Affiliated Hospital of Zunyi Medical University. Written informed consent was obtained from all participants before enrollment.

Eligibility criteria

The inclusion criteria were as follows: diagnosis of RRD; PVR grade C1 or lower; retinal breaks located anterior to the equator; no obvious vitreous or preretinal proliferative changes; retinal detachment involving no more than two quadrants; no previous ocular surgery; and no ocular condition that would substantially interfere with posterior segment examination. Exclusion criteria were PVR greater than C1, severe subretinal proliferation, glaucoma or intraocular pressure greater than 21 mmHg, severe ocular trauma, previous intraocular or refractive surgery, and inflammatory, infectious, or ischemic ocular disease.

Surgical procedures

All operations were performed by the same surgeon under retrobulbar anesthesia. In the conventional scleral buckling group, conjunctival peritomy was performed in the relevant quadrant, the sclera was exposed, and the retinal break and associated degenerative areas were identified and marked under binocular indirect ophthalmoscopy with scleral indentation. External drainage of subretinal fluid was performed when judged necessary. Cryopexy was applied until the retina around the break became mildly whitened. A silicone sponge or encircling band was sutured to achieve adequate buckle height and coverage of the break. Supplemental laser photocoagulation was performed 3–7 days postoperatively when indicated.

In the 25G endoillumination-assisted group, the same ab externo procedure was performed. In addition, a 25G trocar cannula was inserted 3.5 mm posterior to the limbus through a transconjunctival oblique scleral tunnel of approximately 35 degrees, and a xenon endoillumination fiber was introduced into the vitreous cavity at approximately 35% light intensity. Under wide-angle viewing, the surgeon confirmed break location, monitored subretinal fluid drainage, controlled the extent of cryopexy, and assessed the relationship between the buckle indentation and the retinal break. At the end of the procedure, the cannula was removed and the conjunctiva was repositioned.

OCTA acquisition and macular measurements

Preoperative and postoperative examinations at 2, 4, and 12 weeks included BCVA measurement, intraocular pressure, axial length, slit-lamp biomicroscopy, fundus photography or B-scan ultrasonography, and OCTA. Decimal visual acuity was converted to logMAR values for analysis.

OCTA was performed using the same device, scan protocol, and analysis software throughout follow-up. Macular 3 x 3 mm scans were preferred. If a 6 x 6 mm scan was required because of fixation or refractive status, the same scan mode was used for that eye at all visits; values from different scan sizes were not pooled directly. Automated segmentation was used to obtain SCP and DCP images. The SCP was defined primarily from the internal limiting membrane to the inner plexiform layer, and the DCP primarily from the inner nuclear layer to the outer plexiform layer. Vessel density was calculated as the percentage of flow-signal area within the valid measurement area. Foveal, parafoveal, and whole-image values were recorded. mGCC thickness was measured by the built-in software algorithm and included the retinal nerve fiber layer, ganglion cell layer, and inner plexiform layer.

Quality control included adequate signal strength, absence of major blink or motion artifacts, absence of obvious projection artifacts or macular decentration, and agreement between automated segmentation and structural B-scans. Segmentation errors were reviewed and manually corrected when possible. Images that remained unsuitable for quantitative analysis were excluded. OCTA images were acquired by trained examiners who were not involved in the surgery.

Statistical analysis

Statistical analyses were performed using SPSS or R. Continuous variables were assessed for normality using the Shapiro-Wilk test and for homogeneity of variance using the Levene test. Approximately normally distributed variables were summarized as mean +/- standard deviation and compared using independent-samples t tests. Skewed variables were summarized as median and interquartile range and compared using the Mann-Whitney U test. Categorical variables were expressed as number and percentage and compared using the chi-square test or Fisher exact test. Repeated measures, including BCVA, intraocular pressure, axial length, SCP vessel density, DCP vessel density, and mGCC thickness, were analyzed using repeated-measures analysis of variance. Greenhouse-Geisser correction was applied when the sphericity assumption was not met. When follow-up data were missing or OCTA images were excluded, linear mixed models with random intercepts for participants were used as sensitivity analyses. Bonferroni correction was used for multiple comparisons. A two-sided P value less than 0.05 was considered statistically significant.

Results

Baseline characteristics

The baseline characteristics of the two groups are shown in Table 1. Age, sex distribution, laterality, axial length, spherical equivalent, preoperative BCVA, preoperative intraocular pressure, macular involvement,

extent of detachment, number and location of breaks, PVR grade, and time from symptom onset to surgery were comparable between groups (all $P > 0.05$).

Table 1
Baseline characteristics

Characteristic	Conventional SB	25G-assisted SB	Statistic	P value
Eyes, n	32	32	-	-
Age, years	34.9 +/- 8.2	35.7 +/- 7.9	t = -0.397	0.692
Sex, male/female	19/13	20/12	chi-square = 0.000	1.000
Eye, right/left	17/15	18/14	chi-square = 0.000	1.000
Axial length, mm	25.42 +/- 1.77	25.36 +/- 1.69	t = 0.139	0.890
Spherical equivalent, D	-4.25 +/- 2.31	-4.08 +/- 2.18	t = -0.303	0.763
Preoperative BCVA, logMAR	0.96 +/- 0.35	0.94 +/- 0.36	t = 0.225	0.822
Preoperative IOP, mmHg	14.8 +/- 2.7	14.5 +/- 2.6	t = 0.453	0.652
Macula involved, yes/no	16/16	15/17	chi-square = 0.000	1.000
Detachment extent, <=1/>1 quadrant	19/13	20/12	chi-square = 0.000	1.000
Retinal breaks, single/multiple	23/9	22/10	chi-square = 0.000	1.000
Break location, superior/inferior/temporal/nasal	14/6/9/3	15/5/8/4	chi-square = 0.333	0.955
PVR grade, <=B/C1	27/5	26/6	Fisher exact test	1.000
Time from onset to surgery, days	5 [3, 7]	4 [3, 7]	Z = -0.546	0.585

Data are shown as mean +/- SD, median [interquartile range], or n. BCVA, best-corrected visual acuity; IOP, intraocular pressure; PVR, proliferative vitreoretinopathy; SB, scleral buckling.

Visual recovery and retinal reattachment

BCVA improved after surgery in both groups (Table 2 and Fig. 1). Repeated-measures analysis showed significant time and group effects for BCVA (time effect: $F = 21.479$, $P < 0.001$; group effect: $F = 12.119$,

P = 0.043). Within-group comparisons showed improvement at 2, 4, and 12 weeks compared with baseline in both groups. The 25G-assisted group had better BCVA at 2 weeks (0.36 +/- 0.14 vs 0.55 +/- 0.13 logMAR, P < 0.001), but between-group differences were no longer significant at 4 or 12 weeks.

The primary retinal reattachment rate was 93.8% (30/32) in the conventional group and 96.9% (31/32) in the 25G-assisted group (P = 1.000). Final retinal reattachment was achieved in all eyes at the last follow-up visit.

Table 2
Visual and anatomical outcomes

Outcome	Conventional SB	25G-assisted SB	P value
Preoperative BCVA, logMAR	0.96 +/- 0.35	0.94 +/- 0.36	0.822
BCVA at 2 weeks, logMAR	0.55 +/- 0.13	0.36 +/- 0.14	< 0.001
BCVA at 4 weeks, logMAR	0.34 +/- 0.12	0.30 +/- 0.12	0.187
BCVA at 12 weeks, logMAR	0.25 +/- 0.10	0.23 +/- 0.11	0.450
Primary retinal reattachment	30/32 (93.8%)	31/32 (96.9%)	1.000
Supplemental laser photocoagulation	5/32 (15.6%)	3/32 (9.4%)	0.704
Additional surgery	2/32 (6.3%)	1/32 (3.1%)	1.000
Final retinal reattachment	32/32 (100.0%)	32/32 (100.0%)	1.000

BCVA values are shown as mean +/- SD. Anatomical outcomes are shown as n/N (%).

Anterior segment parameters and axial length

Anterior chamber depth, lens thickness, and axial length are summarized in Table 3. Group effects were not significant for any of these parameters. Time effects were significant, reflecting early postoperative changes after buckling or encircling. At 2 weeks, anterior chamber depth decreased and lens thickness increased in both groups. Axial length showed a small early postoperative change, but values had largely returned toward baseline by 12 weeks.

Table 3
Anterior segment and axial length

Parameter	Time point	Conventional SB	25G-assisted SB	P value
Anterior chamber depth, mm	Preoperative	3.12 +/- 0.29	3.15 +/- 0.31	0.690
	2 weeks	2.86 +/- 0.31	2.89 +/- 0.30	0.696
	4 weeks	3.01 +/- 0.29	3.04 +/- 0.28	0.675
	12 weeks	3.10 +/- 0.28	3.13 +/- 0.29	0.675
Lens thickness, mm	Preoperative	3.70 +/- 0.28	3.68 +/- 0.27	0.772
	2 weeks	3.84 +/- 0.31	3.81 +/- 0.29	0.690
	4 weeks	3.76 +/- 0.29	3.74 +/- 0.29	0.784
	12 weeks	3.71 +/- 0.27	3.69 +/- 0.27	0.767
Axial length, mm	Preoperative	25.42 +/- 1.77	25.36 +/- 1.69	0.890
	2 weeks	25.50 +/- 1.75	25.51 +/- 1.70	0.982
	4 weeks	25.47 +/- 1.73	25.43 +/- 1.68	0.926
	12 weeks	25.43 +/- 1.74	25.37 +/- 1.67	0.888

Data are shown as mean +/- SD. Repeated-measures results: anterior chamber depth, group $F = 0.613$, $P = 0.581$; time $F = 12.812$, $P = 0.021$; interaction $F = 0.284$, $P = 0.838$. Lens thickness, group $F = 0.497$, $P = 0.521$; time $F = 12.178$, $P = 0.041$; interaction $F = 0.241$, $P = 0.867$. Axial length, group $F = 0.456$, $P = 0.735$; time $F = 12.787$, $P = 0.034$; interaction $F = 0.318$, $P = 0.812$.

Macular OCTA and mGCC findings

Longitudinal OCTA parameters and mGCC thickness are shown in Table 4 and Fig. 2. At baseline, SCP vessel density, DCP vessel density, and mGCC thickness were similar between groups. SCP and DCP vessel density increased slightly after retinal reattachment in both groups; however, neither the group effect nor the group-by-time interaction was significant. mGCC thickness remained stable over the 12-week follow-up period, with no evidence of persistent thinning in the 25G-assisted group.

Table 4
Macular OCTA findings

Parameter	Time point	Conventional SB	25G-assisted SB	P value
SCP vessel density, %	Preoperative	42.6 +/- 4.8	42.9 +/- 4.6	0.799
	2 weeks	43.3 +/- 4.4	43.5 +/- 4.2	0.853
	4 weeks	44.0 +/- 4.1	44.2 +/- 4.0	0.844
	12 weeks	44.8 +/- 3.8	45.0 +/- 3.7	0.832
DCP vessel density, %	Preoperative	45.8 +/- 5.2	46.1 +/- 5.0	0.815
	2 weeks	46.5 +/- 4.8	46.8 +/- 4.6	0.799
	4 weeks	47.2 +/- 4.6	47.5 +/- 4.4	0.791
	12 weeks	48.1 +/- 4.2	48.4 +/- 4.1	0.773
mGCC thickness, μm	Preoperative	89.1 +/- 7.4	89.6 +/- 7.1	0.784
	2 weeks	88.8 +/- 7.1	89.3 +/- 6.9	0.776
	4 weeks	89.2 +/- 6.9	89.7 +/- 6.7	0.770
	12 weeks	89.8 +/- 6.5	90.2 +/- 6.4	0.805

Data are shown as mean +/- SD. SCP, superficial capillary plexus; DCP, deep capillary plexus; mGCC, macular ganglion cell complex. Repeated-measures results: SCP, group $F = 0.067$, $P = 0.797$; time $F = 4.862$, $P = 0.004$; interaction $F = 0.102$, $P = 0.959$. DCP, group $F = 0.049$, $P = 0.825$; time $F = 5.437$, $P = 0.002$; interaction $F = 0.083$, $P = 0.969$. mGCC, group $F = 0.035$, $P = 0.852$; time $F = 0.768$, $P = 0.513$; interaction $F = 0.071$, $P = 0.975$.

Safety outcomes

Safety outcomes are summarized in Table 5 and Fig. 3. In the 25G-assisted group, five eyes showed an intraoperative fiber track or mild local vitreous opacity; these changes diminished during follow-up. The rates of transient intraocular pressure elevation, epiretinal membrane, PVR progression, iatrogenic retinal break, and lens-related adverse events did not differ significantly between groups. No vitreous hemorrhage, choroidal hemorrhage, retinal incarceration, infectious endophthalmitis, or other severe complication was observed during follow-up.

Table 5
Postoperative safety outcomes

Safety outcome	Conventional SB	25G-assisted SB	Test	P value
Vitreous disturbance or fiber track	0/32 (0.0%)	5/32 (15.6%)	Fisher exact test	0.053
Transient IOP elevation	3/32 (9.4%)	4/32 (12.5%)	Fisher exact test	1.000
Epiretinal membrane	2/32 (6.3%)	1/32 (3.1%)	Fisher exact test	1.000
PVR progression	2/32 (6.3%)	1/32 (3.1%)	Fisher exact test	1.000
Iatrogenic retinal break	1/32 (3.1%)	0/32 (0.0%)	Fisher exact test	1.000
Lens injury or cataract progression	1/32 (3.1%)	1/32 (3.1%)	Fisher exact test	1.000

Data are shown as n/N (%). IOP, intraocular pressure; PVR, proliferative vitreoretinopathy.

Discussion

The present study focused on a subgroup of patients with RRD for whom an ab externo approach is usually reasonable: young phakic eyes with mild PVR, anterior retinal breaks, and limited detachment. In such eyes, the posterior vitreous cortex often remains adherent to the inner retina, and routine PPV may require artificial posterior vitreous detachment. That maneuver can be technically difficult and may expose patients to iatrogenic breaks, lens injury, and intraocular pressure changes. The purpose of adding 25G endoillumination was therefore not to extend scleral buckling to all forms of RRD, but to improve the visualization of cases that were already suitable for scleral buckling.

Anatomical success was high in both groups. The primary reattachment rate was 93.8% in the conventional group and 96.9% in the 25G-assisted group, and all eyes were reattached at final follow-up. These findings are consistent with the established role of scleral buckling in selected phakic RRD [4, 7]. The more notable difference between groups was the speed of visual recovery: BCVA at 2 weeks was better in the 25G-assisted group, whereas values at 4 and 12 weeks were similar. This pattern suggests that improved visualization may facilitate a smoother early postoperative course rather than fundamentally changing the mechanism of retinal reattachment.

Several intraoperative factors may explain the early functional difference. Endoillumination provides a direct, upright, magnified view of the peripheral retina and allows the surgeon to adjust the angle and intensity of illumination according to the location of the break. Compared with binocular indirect ophthalmoscopy, this can make small peripheral breaks, lattice degeneration, subretinal fluid dynamics,

and buckle indentation easier to judge. It may also reduce the uncertainty in matching the buckle height and width to the break. These advantages are in line with previous experience using chandelier illumination, wide-angle viewing, and microscope-assisted external surgery [8–10, 13].

The control of retinopexy is also relevant. Cryopexy that is too light may fail to create firm chorioretinal adhesion, whereas excessive cryopexy can disrupt the blood-retinal barrier, damage the retinal pigment epithelium, and potentially promote inflammation or PVR [12]. Under endoillumination, the whitening of the retina around the break and the extension of the cryopexy reaction could be observed more directly. Similarly, after external drainage, the surgeon could reassess residual subretinal fluid and the position of the buckle indentation. These practical advantages may help avoid under-treatment, over-treatment, and buckle misalignment.

The early changes in anterior chamber depth, lens thickness, and axial length were broadly similar between groups. These changes are most plausibly related to the transient mechanical effects of buckling or encircling rather than to the 25G illumination channel itself. Conventional scleral buckling, particularly when excessive or poorly positioned, may alter axial length, refraction, ocular motility, and anterior segment perfusion. In this study, no sustained between-group difference in ocular morphology was detected, suggesting that the single 25G channel did not add a measurable structural burden over the short follow-up period.

OCTA was included because visual recovery after RRD repair depends on more than anatomical reattachment. Previous studies have shown that macular microvascular and outer retinal abnormalities may persist after successful reattachment, particularly in eyes with macular detachment [2, 3]. In our cohort, SCP and DCP vessel densities increased slightly over time in both groups, and there was no significant group effect or group-by-time interaction. mGCC thickness also remained stable. These findings argue against a detectable short-term adverse effect of a controlled 25G endoillumination channel on macular microcirculation or inner retinal structure.

The OCTA findings should be interpreted with appropriate caution. Vessel density represents flow signal within a defined scan area and is not identical to true tissue perfusion. Scan size, segmentation boundaries, projection artifacts, signal strength, and fixation stability can all influence the measurements. For this reason, we used the same device and acquisition protocol during follow-up and excluded images with uncorrectable artifacts or segmentation errors. Even with these precautions, OCTA results should be interpreted together with BCVA, structural OCT findings, ellipsoid zone integrity, and clinical examination.

Endoillumination is not risk-free. A 25G probe enters the vitreous cavity, and potential risks include vitreous disturbance, lens touch, retinal traction, iatrogenic break, light toxicity, infection, and PVR progression. In the present study, five eyes in the 25G-assisted group showed transient vitreous disturbance or fiber tracks, but these findings decreased during follow-up. No severe complication related to endoillumination was observed. The practical safeguards used in this series included low illumination intensity, avoidance of prolonged macular exposure, minimal movement of the fiber in the

vitreous cavity, no unnecessary intraocular manipulation, and careful inspection of the sclerotomy site and peripheral retina before closure.

The procedure also has clear boundaries. It should not be regarded as a substitute for PPV in complex RRD, giant retinal tears, posterior breaks, dense vitreous hemorrhage, severe media opacity, recurrent detachment, or significant vitreoretinal traction. In such settings, PPV or combined surgery remains more appropriate. The value of 25G endoillumination-assisted scleral buckling lies in improving visibility and surgical confidence in eyes that are already suitable for ab externo repair.

This study has limitations. The follow-up was limited to 12 weeks, which is insufficient for assessing long-term changes in macular vessel density, mGCC thickness, external limiting membrane integrity, and ellipsoid zone recovery. The sample size was modest, and subgroup analyses according to macular involvement, duration of detachment, number and location of breaks, encircling procedure, and degree of myopia were not adequately powered. In addition, FAZ area, FAZ perimeter, FD-300, choriocapillaris perfusion, and outer retinal layer thickness were not analyzed systematically. Larger studies with longer follow-up and standardized OCTA protocols are needed to define the long-term safety profile and the optimal indications for this technique.

Conclusions

In selected young phakic patients with RRD, 25G endoillumination-assisted scleral buckling improved the visualization of peripheral retinal breaks, subretinal fluid, buckle indentation, and cryopexy. The technique was associated with faster BCVA recovery at 2 weeks, while 4- and 12-week visual outcomes and anatomical reattachment rates were similar to those achieved with conventional scleral buckling. OCTA follow-up did not demonstrate additional SCP or DCP vessel density reduction or mGCC thinning in the 25G-assisted group. When performed with strict case selection, controlled low illumination, minimal intraocular manipulation, and careful peripheral retinal inspection, 25G endoillumination-assisted scleral buckling appears to be a safe short-term adjunct to conventional ab externo RRD repair.

Abbreviations

BCVA
best-corrected visual acuity
DCP
deep capillary plexus
FAZ
foveal avascular zone
IOP
intraocular pressure
mGCC
macular ganglion cell complex

OCTA
optical coherence tomography angiography
PPV
pars plana vitrectomy
PVR
proliferative vitreoretinopathy
RRD
rhegmatogenous retinal detachment
RPE
retinal pigment epithelium
SB
scleral buckling
SCP
superficial capillary plexus.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of The Second Affiliated Hospital of Zunyi Medical University. The study adhered to the Declaration of Helsinki. Written informed consent was obtained from all participants.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

WG and GS conceived and designed the study. WG collected the clinical data and drafted the manuscript. WG and GS analyzed and interpreted the data. GS supervised the study and critically revised the manuscript. Both authors read and approved the final manuscript.

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Not applicable.

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Figures

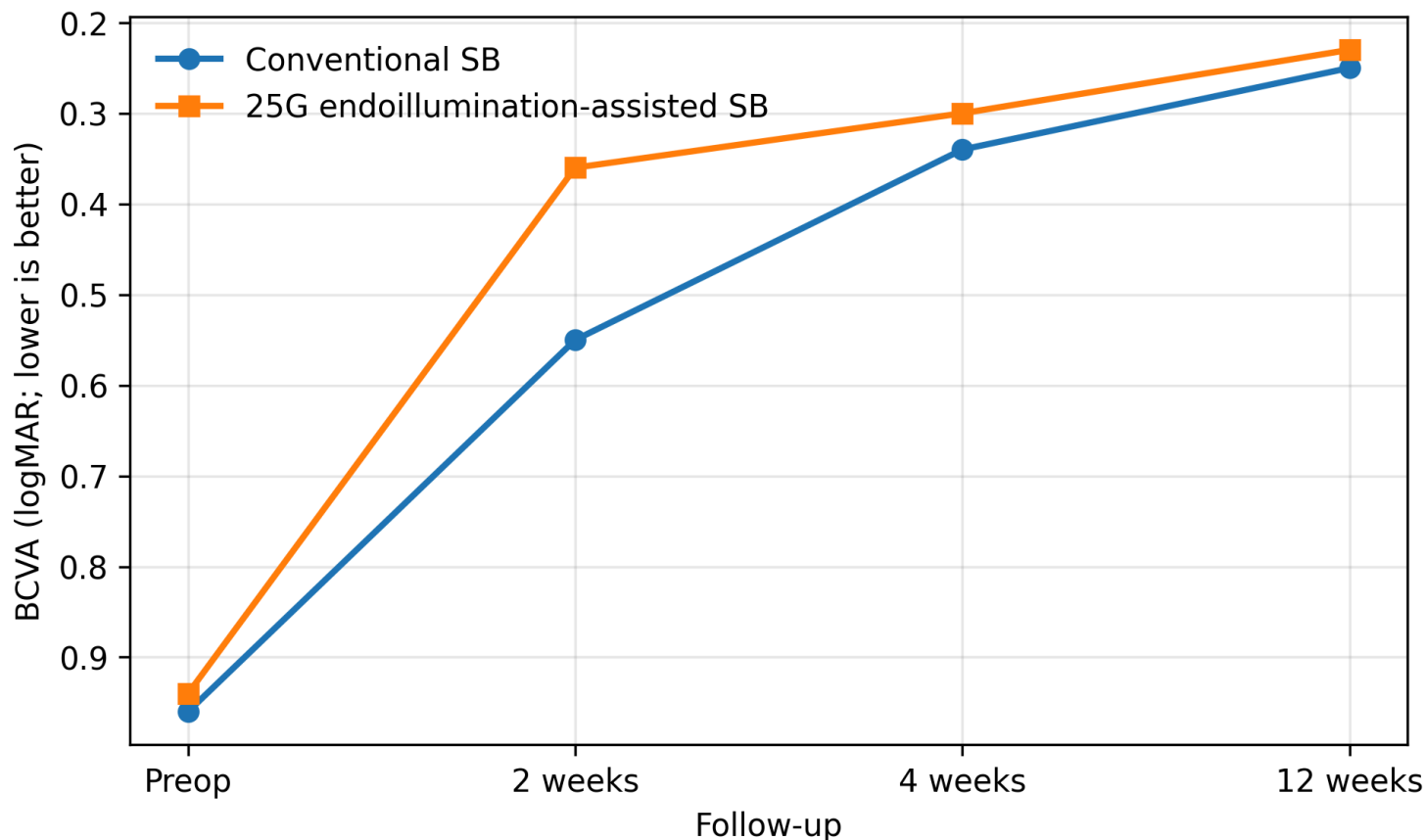


Figure 1

BCVA recovery. Mean BCVA in logMAR units over 12 weeks. Lower values indicate better visual acuity.

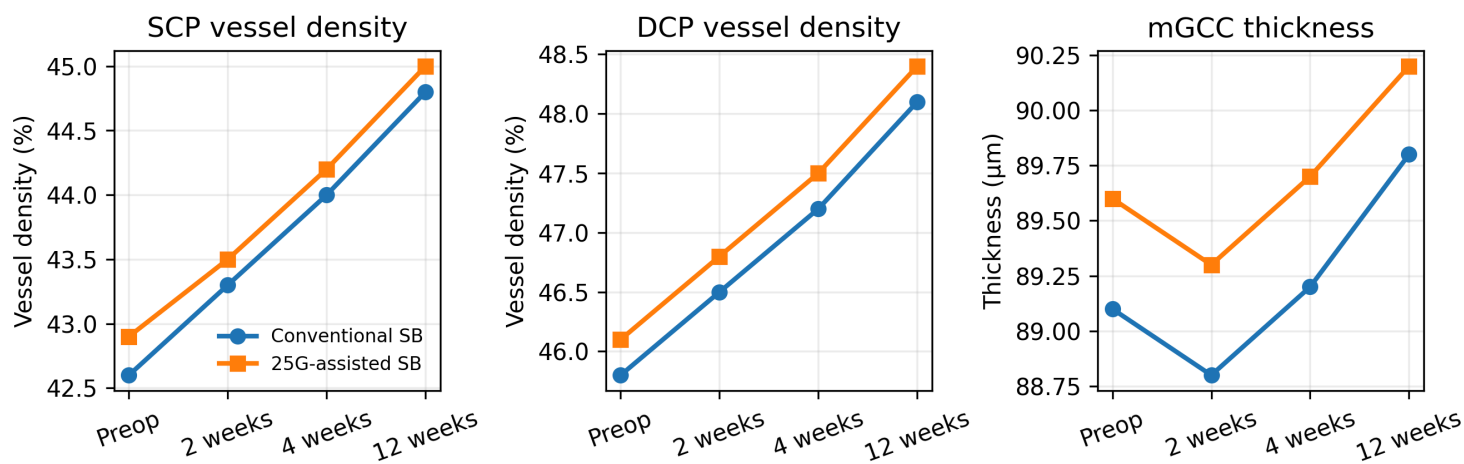


Figure 2

Macular OCTA trends. Longitudinal changes in SCP vessel density, DCP vessel density, and mGCC thickness.

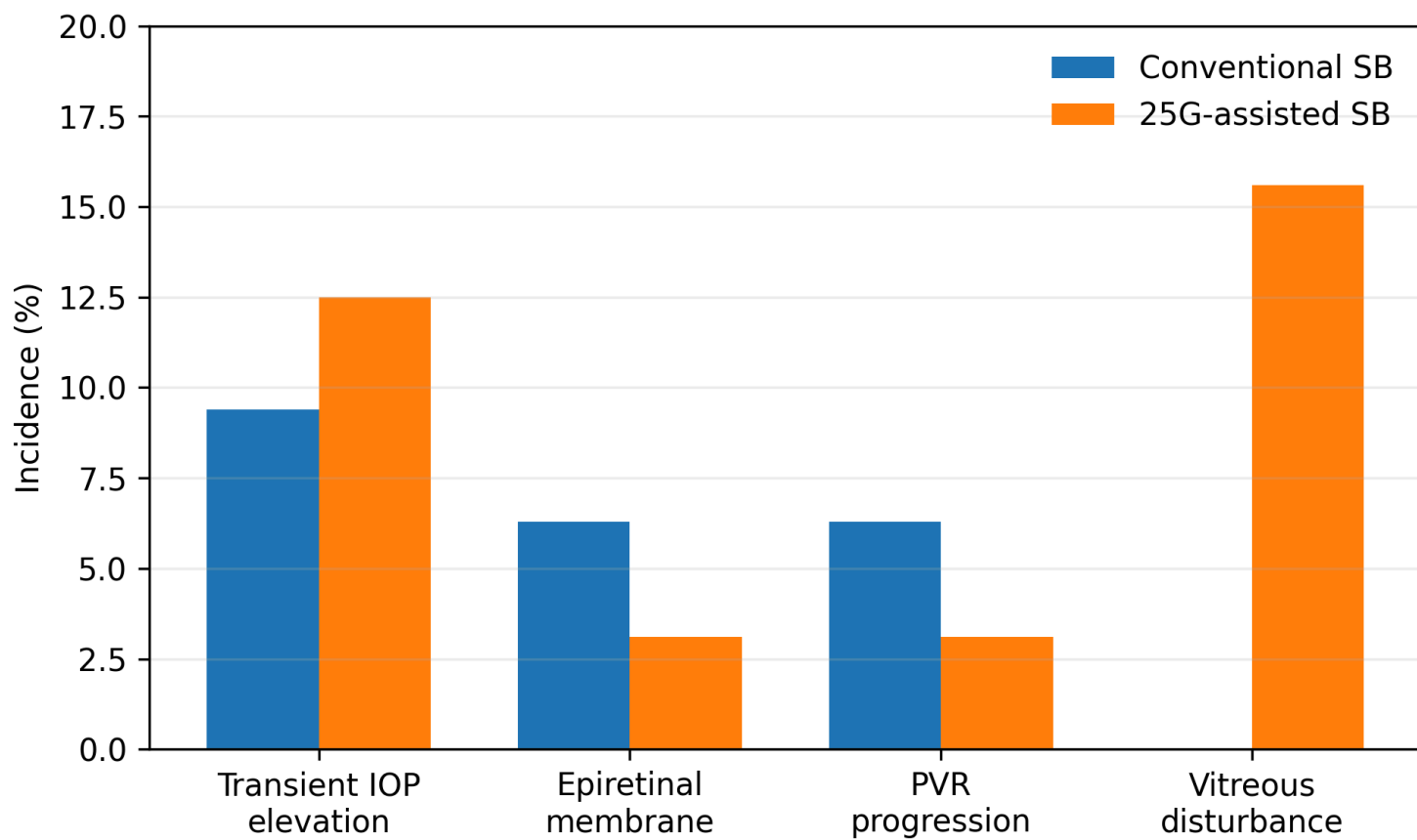


Figure 3

Postoperative adverse events. Incidence of selected postoperative events in the two treatment groups.