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Evaluation of Optic Nerve Head Vessel Density in Glaucoma Patients After Unilateral Phacoemulsification Using Solix Optical Coherence Tomography Angiography: Long-Term Results

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What is already known on this topic?

- *Cataract surgery (phacoemulsification) is known to lower IOP and enlarge the anterior chamber angle in glaucoma patients.*
- *Optical coherence tomography angiography provides noninvasive assessment of optic nerve head VD.*
- *The long-term impact of cataract extraction on optic nerve head microvasculature in glaucoma patients remains unclear.*

What this study adds on this topic?

- *This study shows that pseudophakic eyes have significantly higher optic nerve head VD compared with phakic fellow eyes in glaucoma patients after unilateral phacoemulsification.*
- *The increase in VD was associated with lower postoperative IOP and angle widening.*
- *These findings suggest that timely cataract surgery in glaucoma patients with coexisting cataract may confer additional vascular benefits and potentially improve disease prognosis.*

Abstract

Objective: To compare the optic nerve head vessel density (VD) between phakic and pseudophakic eyes in glaucoma patients who underwent unilateral cataract surgery.

Methods: A total of 58 eyes of 29 glaucoma patients with unilateral phacoemulsification were included in the study. Preoperative intraocular pressure (IOP) and angle grade (according to Shaffer classification), as well as postoperative mean IOP, angle grade, retinal nerve fiber layer (RNFL) thickness, central corneal thickness (CCT), and peripapillary vessel density (VD) parameters were compared between phakic and pseudophakic eyes. VD measurements were obtained using the Solix optical coherence tomography angiography (OCT-A) device, which features a 17% wider radial peripapillary capillary (RPC) analysis area compared with the AngioVue system. All scans had signal strength index ≥6/10. The mean follow-up period was 42 months (range, 24-84 months).

Results: Preoperative IOP, angle grade, axial length and postoperative CCT, RNFL thickness, endothelial cell density were similar between groups ($P > .05$). Postoperatively, pseudophakic eyes had significantly lower mean IOP ($P = .001$) and greater angle width ($P = .008$). Mean RPC VD—the predefined primary outcome—was significantly higher in pseudophakic eyes compared with phakic eyes ($P = .001$). Grid-based VD values were also increased, particularly in the superior sector ($P = .009$).

Conclusion: The lower postoperative IOP and wider iridocorneal angle observed in pseudophakic eyes may contribute to improved optic nerve head perfusion and sustained enhancement of peripapillary microvascular density. These long-term paired-eye findings indicate potential microvascular benefits of pseudophakia, although their prognostic significance remains to be confirmed in future longitudinal studies.

Keywords: Glaucoma, phacoemulsification, optical coherence tomography angiography, radial peripapillary capillaries vessel density, retinal nerve fiber layer

Introduction

Glaucoma is a multifactorial optic neuropathy characterized by progressive retinal ganglion cell loss and structural damage to the optic nerve head, leading to irreversible visual field defects. Although intraocular pressure (IOP) is the most important modifiable risk factor, vascular dysregulation and impaired ocular perfusion have also been implicated in the pathogenesis of the disease.[1,2] Optical coherence tomography angiography (OCT-A) has emerged as a non-invasive modality that enables quantitative evaluation of peripapillary and macular microvasculature, providing additional insights into glaucomatous damage.[3,4]

Several studies using OCT-A have demonstrated reduced radial peripapillary capillary (RPC) vessel density (VD) in glaucomatous eyes, with significant correlations to retinal nerve fiber layer (RNFL) thickness and visual field indices.[5–7] While most of these studies employed the Optovue AngioVue system (2.0-4.0 mm annulus), the newer Solix platform provides extended scan coverage

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(2.0-4.5 mm annulus), approximately 17% larger than AngioVue, with improved resolution and the ability to perform grid-based VD analysis.[8,9] This advancement may enhance the ability to detect microvascular alterations associated with glaucoma progression.

Phacoemulsification cataract surgery in glaucoma patients has been shown not only to improve visual acuity but also to reduce IOP and deepen the anterior chamber angle, making it a strategic intervention in glaucoma management.[10-12] Cataract surgery–related IOP reduction has been attributed to improved trabecular outflow and widening of the iridocorneal angle.[13,14] In addition, removal of the opacified crystalline lens may enhance the quality of OCT-A images, facilitating a more reliable evaluation of peripapillary microvasculature. However, the impact of cataract surgery on OCTA-derived parameters—such as RPC VD and RNFL thickness—has been less extensively investigated. In mild-to-moderate cataracts, vessel densities within the optic disc increased 3 months postoperatively, with no significant change in the peripapillary region.[15] Moreover, short-term studies have shown that retinal vasculature and peripapillary VD significantly increase within the first month after cataract surgery, although the long-term persistence of these changes remains uncertain.[16]

In this context, the present study aimed to evaluate long-term changes in optic nerve head VD using the Solix OCT-A device in glaucoma patients who underwent unilateral phacoemulsification. By comparing pseudophakic eyes with their fellow phakic eyes, the authors sought to investigate the influence of cataract surgery on vascular and structural parameters, including RPC VD, grid-based VD, and RNFL thickness, thereby providing long-term paired-eye evidence on the microvascular and structural effects of cataract surgery in glaucoma. The primary outcome was defined as mean RPC VD, owing to its established reproducibility and physiological relevance to glaucomatous microcirculation.

Methods

This retrospective comparative study included glaucoma patients who underwent unilateral phacoemulsification surgery at the Glaucoma Clinic of Dışkapı Yıldırım Beyazıt Training and Research Hospital between January 2018 and June 2023. The fellow phakic eye served as an internal control. The study adhered to the tenets of the Declaration of Helsinki and was approved by the University of Health Sciences Ankara Etlik City Hospital Ethics Committee (approval number: AEŞH-BADEK1-2025-339). Written informed consent was obtained from all participants.

The present study included a total of 58 eyes from 29 patients. All patients underwent a comprehensive ophthalmic examination, including best-corrected visual acuity, slit-lamp biomicroscopy, IOP measurement with Goldmann applanation tonometry, iridocorneal angle assessment by gonioscopy using a Goldmann 3-mirror lens with grading according to the Shaffer classification, and dilated fundus examination.

Visual field testing was performed using the Humphrey Field Analyzer (HFA; Carl Zeiss Meditec, Dublin, Calif, USA) with the 24-2 SITA Standard program, and the visual field mean deviation (MD) values were recorded. Axial length was measured using Lenstar LS 900 (Haag-Streit AG, Koeniz, Switzerland), and endothelial cell density (ECD) was evaluated with the Tomey EM-4000 specular microscope (Tomey Corporation, Nagoya, Japan).

The stage of glaucoma was classified according to the Hodapp–Parrish–Anderson criteria based on visual field MD values. All patients were under stable topical antiglaucoma treatment, which typically included prostaglandin analogs, beta-blockers, carbonic anhydrase inhibitors, or alpha-agonists, either as monotherapy or in fixed combinations.

Patients were eligible for inclusion if they had a confirmed diagnosis of glaucoma and were under regular follow-up. Only those who had undergone phacoemulsification surgery in 1 eye while the fellow eye remained phakic were considered. In addition, complete postoperative Solix OCT-A data for both eyes had to be available, and the postoperative follow-up period was required to be at least 24 months. All patients were maintained on stable medical therapy throughout the study period. No reduction or escalation in glaucoma medication was performed after phacoemulsification. Importantly, most patients were using a single topical agent bilaterally.

Patients were excluded if they had a history of bilateral phacoemulsification surgery or any other previous ocular surgery, including glaucoma surgery. Eyes with poor-quality OCT-A images were also excluded, as were those with concomitant ocular pathologies, such as diabetic retinopathy, uveitis, or macular edema.

Cataract Surgical Procedure

All cataract surgeries were performed using the Centurion Vision System (Alcon Laboratories, Inc., Fort Worth, Tex, USA). After topical anesthesia, a standard 2.2-mm clear corneal self-sealing incision was created. Continuous curvilinear capsulorhexis was performed, followed by hydrodissection and phacoemulsification of the nucleus. Cortical cleanup was achieved with irrigation/aspiration, and a foldable hydrophobic acrylic intraocular lens was implanted into the capsular bag. All procedures were carried out by a single experienced glaucoma surgeon (N.E.) using a standardized stop-and-chop technique to minimize variability in ultrasound energy delivery and surgical parameters.

Optical Coherence Tomography Angiography

Optical coherence tomography angiography was performed using the Solix OCT-A device (Optovue, Fremont, Calif, USA), which provides wide-field, high-resolution imaging and an extended scanning area of the RPC ring. In the Solix system, VD measurements of the RPC are obtained within an annular region extending from 2.0 mm to 4.5 mm around the optic disc. By comparison, the previous-generation AngioVue system uses a 2.0–4.0 mm peripapillary annulus; thus, Solix covers approximately 17% larger area for peripapillary capillary analysis.

Both phakic and pseudophakic eyes of each patient were scanned using the 6 × 6 mm optic nerve head protocol. Global and sectoral RPC VD values were automatically calculated. In addition, grid-based VD values were recorded, both with and without large-vessel masking.

All scans were acquired by a single experienced operator (M.Y.) to ensure consistency and minimize inter-operator variability. Each eye was scanned at least twice, and the best-quality image—defined as having a signal strength index (SSI) of ≥6/10—was selected for analysis, in accordance with the manufacturer's user manual and prior validation studies indicating that an SSI of 6/10 or higher represents a reliable threshold for quantitative OCT-A analysis and does not significantly influence VD or segmentation accuracy. The Solix system also incorporates real-time eye tracking, motion correction, and projection artifact removal technologies to further enhance image stability and segmentation precision.

RNFL thickness was measured using the optic disc cube protocol of the device, based on automated segmentation of the internal limiting membrane and the RNFL boundary. The RNFL thickness was analyzed within a 3.45 mm peripapillary ring centered on the optic disc, consistent with the device's default protocol.

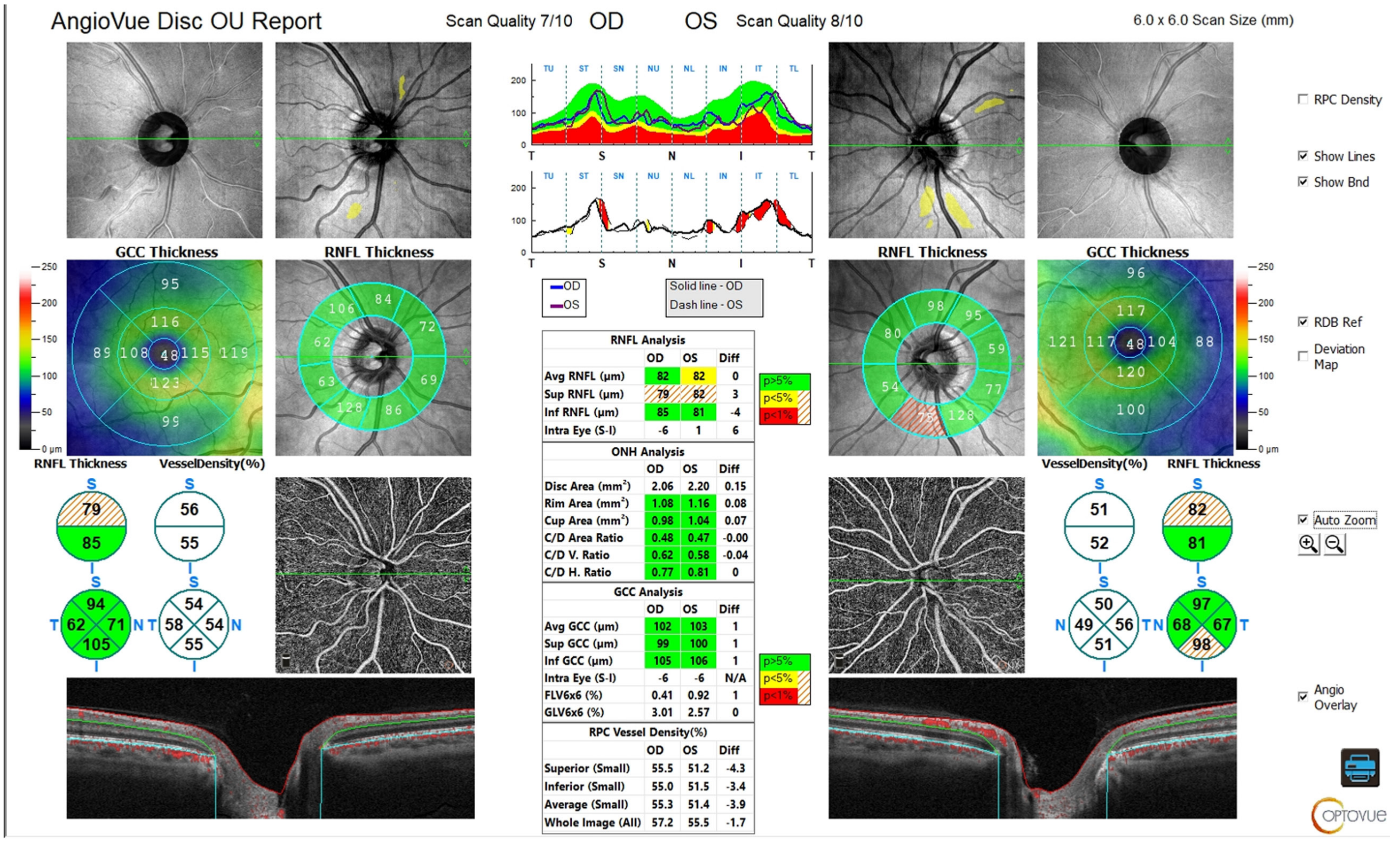

Figure 1. Solix OCT-A Disc Angio output (AngioVue Disc OU report) showing radial peripapillary capillary (RPC) vessel density, retinal nerve fiber layer (RNFL) thickness, and ganglion cell complex (GCC) thickness. This protocol enables simultaneous vascular and structural assessment without the need for additional disc or retina cube scans.

Central corneal thickness (CCT) was measured using the anterior segment module of the Solix system, which provides pachymetric mapping and angle imaging capabilities in addition to posterior segment angiography.

Statistical Analysis

The statistical software package SPSS v.18.0 for Windows (SPSS Inc., IBM Corp., Chicago, IL, USA) was used for data analysis. Continuous variables were expressed as mean ± standard deviation (mean ± SD) and 95% confidence intervals (95% CI). A *P*-value < .05 was considered statistically significant. The normality of the data distribution was tested using the Shapiro–Wilk test. Since each patient contributed 1 pseudophakic and 1 phakic eye, all inter-eye comparisons were analyzed using paired-samples *t*-tests for normally distributed data and the Wilcoxon signed-rank test for non-normally distributed data. This approach accounted for within-subject correlations and avoided inflation of type I error. Categorical variables were compared using the chi-square (χ^2) test.

The primary outcome was defined as mean RPC VD, while other OCT-A parameters were analyzed as secondary outcomes. Additionally, effect sizes (Cohen's d) and 95% CIs were calculated to quantify the magnitude and precision of observed differences.

An a priori power analysis was performed using G*Power (version 3.1.9.4; University of Düsseldorf, Germany) for a 2-tailed paired-samples *t*-test with α = 0.05 and Cohen's dz = 0.60. With 29 matched pairs (58 eyes), the achieved statistical power was 87.7%. The assumed effect size (dz = 0.60) was considered moderate and clinically plausible, reflecting an expected 2-3% within-subject difference in OCT-A VD based on prior reproducibility data in glaucoma.

Results

A total of 43 glaucoma patients who had undergone unilateral phacoemulsification between January 2018 and June 2023 were initially identified. Of these, 14 patients were excluded from the final analysis: 4 underwent trabeculectomy during follow-up, 3 received intravitreal injections for diabetic macular edema, 5 underwent phacoemulsification in the fellow eye, and 2 had a postoperative follow-up shorter than 24 months. After applying the inclusion and exclusion criteria, 29 patients (58 eyes) were eligible for analysis. The study cohort included 19 females and 10 males, with a mean age of 72.1 ± 5.6 years.

Clinical and structural parameters comparing phakic and pseudophakic fellow eyes are presented in Table 1. Among the analyzed variables, axial length, preoperative IOP, and preoperative angle grade (Shaffer classification) represented baseline values obtained before cataract surgery. All other parameters corresponded to the most recent postoperative visit, with a minimum follow-up of 24 months. The variable "Postoperative Mean IOP" represents the average of IOP values recorded across all postoperative visits during the follow-up period.

There were no significant differences between phakic and pseudophakic eyes in terms of preoperative IOP (17.4 ± 2.6 vs. 17.1 ± 2.9 mmHg, *P* = .508) or preoperative angle grade (2.2 ± 0.6 vs. 2.2 ± 0.7, *P* = 1.0). Similarly, no significant differences were found in RNFL thickness values, including superior (83.7 ± 15.5 vs. 82.3 ± 13.4 µm, *P* = .803), inferior (76.7 ± 19.6 vs. 80.9 ± 16.4 µm, *P* =

Table 1. Paired Comparison of Clinical, Structural, and Ocular Parameters Between Phakic And Pseudophakic Fellow Eyes in Glaucoma Patients

	Phakic Eyes	Pseudophakic Eyes	*P*
Axial length (mm)	23.3 ± 0.9	23.2 ± 0.9	.962*
Endothelial cell density (cells/mm²)	2073 ± 329	2003 ± 339	.216*
Visual field mean deviation (dB)	-8.5 ± 4.2	-8.1 ± 3.9	.585*
Number of glaucoma medications	1.2 ± 0.5	1.1 ± 0.4	.083**
Signal strength index	0.79 ± 0.09	0.85 ± 0.07	**.003****
Glaucoma stage (early/moderate/advanced)	10/11/8	12/11/6	.792***
Central corneal thickness (µm)	533.3 ± 28.7	533.9 ± 31.6	.868*
RNFL superior (µm)	83.7 ± 15.5	82.3 ± 13.4	.803*
RNFL inferior (µm)	76.7 ± 19.6	80.9 ± 16.4	.283*
Mean RNFL (µm)	80.1 ± 16.1	81.7 ± 14.2	.627*
Pre-operative IOP (mmHg)	17.4 ± 2.6	17.1 ± 2.9	.508*
Postoperative mean IOP (mmHg)	15.8 ± 2.5	14.1 ± 2.1	**.001***
Preoperative angle grade (Shaffer)	2.2 ± 0.6	2.2 ± 0.7	1.0**
Postoperative angle grade (Shaffer)	2.2 ± 0.7	2.7 ± 0.5	**.008****

RNFL, retinal nerve fiber layer; IOP, intraocular pressure; mmHg, millimeters of mercury; µm, micrometer; dB, decibel.
**P*, paired-samples *t*-test.
***P*, Wilcoxon signed-rank test.
****P*, chi-square test.
Bold values indicate statistically significant differences between groups (P-value < .05).

.283), and mean RNFL thickness (80.1 ± 16.1 vs. 81.7 ± 14.2 µm, *P* = .627). CCT also did not differ significantly between pseudophakic and phakic eyes (533.9 ± 31.6 vs. 533.3 ± 28.7 µm, *P* = .868). No significant differences were observed in axial length (23.2 ± 0.9 mm vs. 23.3 ± 0.9 mm, *P* = .962), visual field mean deviation (MD) (–8.1 ± 3.9 dB vs. −8.5 ± 4.2 dB, *P* = .585), glaucoma stage (early/moderate/advanced: 12/11/6 vs. 10/11/8, *P* = .792), or number of glaucoma medications (1.1 ± 0.4 vs. 1.2 ± 0.5, *P* = .083). ECD, evaluated as an indirect indicator of intraoperative energy exposure, was comparable between pseudophakic and phakic eyes (2003 ± 339 cells/mm² vs. 2073 ± 329 cells/mm², *P* = .216).

In contrast, pseudophakic eyes demonstrated a significantly lower mean postoperative IOP compared with phakic eyes (14.1 ± 2.1 vs. 15.8 ± 2.5 mmHg, *P* = .001). Moreover, the postoperative angle grade was significantly greater in pseudophakic eyes (2.7 ± 0.5 vs. 2.2 ± 0.7, *P* = .008). All OCT-A scans had a SSI ≥ 6/10. Although pseudophakic eyes showed slightly higher SSI values (0.85 ± 0.07 vs. 0.79 ± 0.09, *P* = .003), both groups exceeded the manufacturer's recommended quality threshold.

OCT-A–derived peripapillary vascular parameters are summarized in Table 2. The mean RPC VD—the predefined primary outcome—was significantly higher in pseudophakic eyes compared with phakic eyes (51.1 ± 2.7 vs. 49.0 ± 2.9, *P* = .001). Sectoral analysis revealed significantly higher superior RPC VD (51.7 ± 2.8 vs. 49.7 ± 2.8, *P* = .001) and inferior RPC VD (50.4 ± 3.4 vs. 48.3 ± 4.2, *P* = .004) in pseudophakic eyes. Whole-image RPC VD was also greater in pseudophakic eyes (54.3 ± 1.9 vs. 53.1 ± 2.5, *P* = .010). Grid-based VD values were consistently higher in pseudophakic eyes, with a significant difference in the superior sector (51.8 ± 2.9 vs. 50.1 ± 2.9, *P* = .009), whereas the inferior sector difference did not reach statistical significance (50.1 ± 3.4% vs. 48.8 ± 4.3%, *P* = .072).

Discussion

In the present study, the authors evaluated the long-term effects of unilateral phacoemulsification on structural and vascular parameters in glaucoma patients using the Solix OCT-A device. The authors' main findings were that pseudophakic eyes demonstrated significantly lower mean IOP and greater angle width compared with their fellow phakic eyes. In addition, peripapillary VD, including mean RPC VD, sectoral RPC values, and whole-image measurements, was significantly higher in pseudophakic eyes.

Table 2. Paired Comparison of Vascular Parameters Between Phakic and Pseudophakic Fellow Eyes In Glaucoma Patients

	Phakic eyes	Pseudophakic Eyes	*P*
Grid-based VD Superior	50.1 ± 2.9	51.8 ± 2.9	**.009***
Grid-based VD Inferior	48.8 ± 4.3	50.1 ± 3.4	.072*
RPC VD Superior	49.7 ± 2.8	51.7 ± 2.8	**.001***
RPC VD Inferior	48.3 ± 4.2	50.4 ± 3.4	**.004***
Mean RPC VD	49.0 ± 2.9	51.1 ± 2.7	**.001***
RPC VD Whole Image	53.1 ± 2.5	54.3 ± 1.9	**.010***

RPC, radial peripapillary capillary; VD, vessel density.
Bold values indicate statistically significant differences between groups (P-value < .05).

Grid-based VD was also increased, particularly in the superior sector. In contrast, no significant differences were observed between the 2 eyes regarding RNFL thickness, CCT, axial length, visual field mean deviation, endothelial cell density (ECD), glaucoma stage, or the number of glaucoma medications. These findings confirm that both groups were structurally and functionally comparable, and the observed vascular differences likely reflect true physiological or flow-related effects rather than baseline disparities. Mean RPC VD was designated as the primary outcome owing to its high reproducibility and physiological relevance to peripapillary perfusion. Importantly, the paired-eye design, in which each patient served as their own control, minimized intersubject variability and strengthened the internal validity of the comparisons.

The authors' results regarding IOP reduction and angle widening are consistent with previous studies reporting favorable effects of cataract surgery on aqueous outflow and anterior segment anatomy in glaucoma patients.[10–12] Decompression of the trabecular meshwork and widening of the iridocorneal angle after lens extraction are considered the main mechanisms underlying these changes. The magnitude of IOP reduction observed in authors' cohort (approximately 1.7 mmHg) aligns with earlier reports from the Ocular Hypertension Treatment Study and other large case series.[10,11] Medication regimens remained stable throughout follow-up, suggesting that the vascular and IOP changes were not driven by postoperative adjustments in glaucoma therapy.

The novel finding of this study is the significant increase in peripapillary VD in pseudophakic eyes. Previous studies investigating the impact of cataract surgery on OCTA-derived parameters have yielded inconsistent results. While Zhu et al[15] reported increased inside-disc VD at 3 months without significant peripapillary change, Özkan and Çiloğlu[17] found improved inside-disc capillary density and RNFL thickness but no significant peripapillary VD change. In contrast, Karabulut et al[18] demonstrated significant increases in total, inside-disc, and peripapillary VD as early as 4 weeks after phacoemulsification. Baldascino et al[19] reported a transient increase in peripapillary VD 1 week after surgery, which returned to baseline by 30 days, whereas macular VD remained elevated. Importantly, recent evidence suggests that even the phacoemulsification platform and the amount of ultrasonic energy delivered during surgery may influence OCTA-derived outcomes. Tan et al[20] found that peripapillary VD did not significantly change by 3 months in eyes operated with the Centurion system, whereas a postoperative decline was observed with the Infiniti platform, highlighting the potential role of surgical energy parameters in shaping postoperative results. Although cumulative dissipated energy (CDE) data were unavailable, comparable ECD between groups suggested minimal surgical energy–related bias.

Mechanistically, several explanations are possible. First, IOP reduction itself may enhance peripapillary perfusion. After medical or surgical IOP lowering, multiple studies have demonstrated increases in VD or stabilization of perfusion, with the magnitude of change partly correlating with the extent of IOP reduction (Chen et al[21] ; Chuang et al[22]). However, the literature remains inconsistent. For example, Zéboulon et al[23] found that filtering surgery with substantial IOP reduction produced only minimal changes in peripapillary and macular VD. Similarly, Gillmann et al[24] reported that despite significant IOP lowering after selective laser trabeculoplasty, peripapillary VD did not show sustained improvement, with transient increases confined to the macula. In a more recent trabeculectomy study, Güngör et al[25] also demonstrated no significant changes in peripapillary or macular superficial plexus VD, although deep capillary plexus parameters increased. Taken together, these findings suggest that while IOP lowering may influence ocular microcirculation, the peripapillary vascular response is heterogeneous and may depend on treatment modality, vascular layer assessed, follow-up duration, and measurement variability. The absence of significant inter-eye differences in axial length, glaucoma severity, or medication burden supports that the observed vascular differences were not confounded by disease stage or treatment.

Second, removal of lens opacity improves signal strength and segmentation quality, which can inflate OCTA-derived densities—particularly inside the disc—independent of true biological change; this measurement consideration has been highlighted across cataract cohorts.[15,17–18] However, in this study, both phakic and pseudophakic eyes achieved high-quality scans exceeding the reliability threshold, and none of the phakic eyes had visually significant cataract that could reduce signal strength. Therefore, the higher RPC VD observed in pseudophakia likely reflects a combination of true microvascular adaptation and minor optical advantages rather than measurement artifact. The authors' paired-eye design (minimizing inter-subject confounders) and ≥24-month follow-up argue that the higher RPC VD in pseudophakia may reflect a combination of durable vascular/flow adaptations and persistent signal-quality advantages relative to the fellow phakic eye.

RNFL thickness did not differ between groups, which is plausible over a 2-year horizon in treated glaucoma—especially when structural "floor" effects or segmentation biases are considered—and is also consistent with reports where phacoemulsification altered perfusion metrics more readily than RNFL thickness.[17] Finally, the grid-based analysis (with and without large-vessel masking) adds nuance: the authors' superior-sector differences mirror studies in which sectoral peripapillary changes were more detectable than global averages soon after surgery, whereas inferior sectors were less consistently affected.[19] The moderate effect sizes observed further support that these differences are both statistically and clinically meaningful.

The strengths of this study include the use of fellow phakic eyes as an internal control, minimizing inter-individual variability, and the relatively long follow-up period of at least 24 months. Furthermore, the authors employed the Solix OCT-A platform, which offers a wider peripapillary annulus and improved resolution compared with earlier OCT-A devices. Moreover, all surgeries were performed by a single surgeon using standardized parameters, and postoperative follow-up duration minimized temporal heterogeneity. The study was adequately powered (87.7%) to detect clinically relevant within-subject differences in VD. Nevertheless, several limitations should be acknowledged. The retrospective design and relatively modest sample size may limit the generalizability of the authors' findings. Another limitation is the absence of CDE data for individual surgeries. However, ECD values were available and analyzed as a surrogate marker of intraoperative energy exposure, and no significant difference was observed between eyes, suggesting that energy-related bias was unlikely to have influenced the microvascular results. Although SSI values were high and comparable between groups, distinguishing true hemodynamic improvement from minor optical advantages in pseudophakic eyes remains challenging. Future prospective studies with larger cohorts and stratification by glaucoma subtype are warranted to confirm and extend the authors' observations.

In glaucoma patients with unilateral phacoemulsification, pseudophakic eyes exhibited lower mean IOP, wider iridocorneal angles, and higher peripapillary microvascular density on OCT-A than their fellow phakic eyes at long-term follow-up, without between-eye differences in RNFL thickness or CCT. These findings—concordant with literature showing IOP-related and lens-status–related effects on OCT-A metrics—suggest that phacoemulsification may confer durable microvascular advantages around the optic nerve head while leaving RNFL thickness largely unchanged. Clinically, lens status and scan quality should be considered when interpreting peripapillary OCT-A in glaucoma, and paired-eye or within-eye designs remain valuable to disentangle biological change from measurement artifacts. These results indicate that the observed peripapillary perfusion enhancement reflects a sustained vascular response rather than a transient postoperative change. However, since no longitudinal structure–function progression analysis was performed, the potential prognostic implications remain hypothesis-generating and warrant further prospective evaluation.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of University of Health Sciences Ankara Etlik City Hospital (Approval no: AEŞH-BADEK1-2025-339, Date: August 06, 2025).

Informed Consent: Written informed consent was obtained from all participants.

Peer-review: Externally peer reviewed.

Author Contributions: Concept –N.E.; Design – N.E., M.E.Ö.; Supervision – N.E.; Materials –N.E.; Data Collection and/or Processing – N.E., M.E.Ö.; Analysis and/or Interpretation – N.E.; Literature Search – N.E., M.E.Ö.; Writing Manuscript – N.E.; Critical Review – N.E.

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