

Efficacy of Suprachoroidal Triamcinolone Acetonide in Macular Edema Secondary to Retinal Vascular Disorders: An Analysis of a Cohort

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ABSTRACT

Background: Suprachoroidal triamcinolone acetonide (SCTA) is a posterior-segment corticosteroid delivery option for macular edema. This study examined short-term anatomical, functional and safety outcomes in diabetic macular edema (DME), branch retinal vein occlusion (BRVO) and central retinal vein occlusion (CRVO).

Methods: In this prospective, single-arm interventional case series, one eye per patient received an initial SCTA injection (4 mg/0.1 mL). Best-corrected visual acuity (BCVA, logMAR), central macular thickness (CMT, spectral-domain optical coherence tomography) and intraocular pressure (IOP) were assessed at baseline, 1 month and 3 months. Repeated measurements and diagnostic subgroups were compared using nonparametric tests.

Results: The 652 eyes comprised 349 DME (53.5%), 195 BRVO (29.9%) and 108 CRVO (16.6%) eyes. Mean CMT changed from 484.5 ± 118.9 µm at baseline to 326.4 ± 98.8 µm at 1 month and 359.9 ± 110.1 µm at 3 months (Friedman p < 0.001). Mean BCVA changed from 0.80 ± 0.23 to 0.67 ± 0.26 and 0.69 ± 0.27 logMAR, respectively (p < 0.001). At month 3, 475 eyes (72.9%) achieved a ≥20% CMT reduction and 156 (23.9%) gained ≥2 lines. Reinjection for persistent or recurrent edema occurred in 185 eyes (28.4%). IOP >21 mmHg occurred in 89 eyes (13.7%); 55 (8.4%) required antiglaucoma drops. No endophthalmitis or retinal detachment was reported.

Conclusion: SCTA treatment was associated with improved CMT and BCVA over 3 months, with the greatest mean improvement at 1 month. Retreatment and IOP monitoring remain clinically relevant, and the uncontrolled design precludes comparative efficacy claims.

Keywords: suprachoroidal injection; triamcinolone acetonide; diabetic macular edema; retinal vein occlusion; optical coherence tomography

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INTRODUCTION

Macular edema is an important cause of visual impairment in diabetic retinopathy and retinal vein occlusion (RVO). Diabetic macular edema (DME) results from diabetes-associated disruption of the blood–retinal barrier, whereas branch and central RVO (BRVO and CRVO) can produce macular thickening through venous congestion, vascular leakage and ischemia. Both conditions commonly require repeated assessment and treatment (1,2).

Anti-vascular endothelial growth factor (anti-VEGF) therapy is a principal treatment option for center-involving DME and RVO-associated macular edema. Nevertheless, repeated injections and visits may create practical burdens. Corticosteroids address inflammatory components of vascular permeability but can increase intraocular pressure (IOP) and accelerate cataract progression (1–3).

The suprachoroidal space, between the sclera and choroid, offers a route for preferential posterior-segment drug distribution (4). A phase 3 trial of suprachoroidal triamcinolone acetonide (SCTA) established benefit in noninfectious uveitic macular edema, although this differs etiologically from retinal vascular edema (5). Smaller reports have described short-term anatomical and visual improvements after SCTA for RVO-associated macular edema and DME, including work from Pakistan (6–8). The relative course of early improvement, subsequent attenuation and safety outcomes across DME, BRVO and CRVO remains clinically relevant in routine retina practice.

The objective of this study was to evaluate longitudinal changes in CMT, BCVA and IOP following SCTA in eyes with DME-, BRVO- or CRVO-associated macular edema over 3 months. Secondary analyses described anatomical and functional response, retreatment and ocular adverse events by diagnostic subgroup.

METHODS

Study design and setting

This prospective, single-arm interventional case series was conducted at the Retina Clinic of LRBT Tertiary Eye-Care Centre, Multan Road, Lahore. The study included 652 patients, with one eligible eye evaluated per patient. Eyes were classified by the underlying cause of macular edema as DME, BRVO or CRVO.

Eligibility criteria

Eligible participants were adults with center-involving macular edema and CMT >300 μ m on spectral-domain optical coherence tomography (SD-OCT) attributed to DME, BRVO or CRVO. Exclusion criteria were glaucoma or ocular hypertension, a known steroid response, an intraocular injection within the preceding 3 months, active ocular infection, vitreomacular traction or media opacity preventing adequate OCT assessment.

Treatment and follow-up

Patients received an initial suprachoroidal injection of triamcinolone acetonide at a dose of 4 mg/0.1 mL. The reported procedure used topical anesthesia and 5% povidone–iodine antisepsis, with a microneedle introduced perpendicular to the sclera approximately 4–4.5 mm posterior to the limbus. Assessments were performed at baseline and at 1- and 3-month follow-up visits. Any additional injection administered for persistent or recurrent edema during the 3-month period was included in the reinjection outcome.

Clinical measurements and outcome definitions

BCVA was reported on the logarithm of the minimum angle of resolution (logMAR) scale, for which lower values indicate better visual acuity; a reduction of 0.2 logMAR corresponds approximately to a two-line gain. CMT was measured in micrometers using SD-OCT, and IOP in mmHg using Goldmann applanation tonometry. Longitudinal outcomes comprised BCVA, CMT and IOP at the three scheduled time points.

Anatomical response was defined as a reduction in CMT of at least 20% from baseline at month 3. Functional response was defined as a BCVA improvement of at least 0.2 logMAR at month 3. Elevated follow-up IOP was defined as >21 mmHg at either assessed follow-up. Additional outcomes included use of antiglaucoma medication, cataract progression among phakic eyes, subconjunctival hemorrhage, procedural pain, endophthalmitis, retinal detachment and reinjection for persistent or recurrent macular edema by month 3.

Statistical analysis

Data were analyzed using Python (pandas and SciPy). Continuous measures are presented as mean $\pm$ standard deviation (SD) and categorical outcomes as frequency and percentage. The Friedman test assessed within-eye differences across baseline, month 1 and month 3; Wilcoxon signed-rank tests were used for reported pairwise comparisons. Kruskal–Wallis tests assessed between-diagnosis differences in continuous measurements, and chi-square tests compared categorical frequencies. Spearman rank correlation assessed the association between CMT reduction and BCVA improvement. For selected observed binary outcomes, 95% confidence intervals (CIs) were calculated from the published counts using the Wilson score method. Reported p-values are two-sided, with $p < 0.05$ considered significant; subgroup comparisons are exploratory.

RESULTS

Baseline characteristics

The cohort comprised 652 eyes from 652 patients, including 349 with DME (53.5%), 195 with BRVO (29.9%) and 108 with CRVO (16.6%). Mean age was 57.5 ± 8.8 years, and 348 patients (53.4%) were male. At baseline, eyes in the CRVO group had greater mean CMT and poorer mean BCVA than eyes in the DME and BRVO groups (Table 1).

Table 1. Baseline demographic and ocular characteristics

Characteristic	All (n = 652)	DME (n = 349)	BRVO (n = 195)	CRVO (n = 108)	p-value
Age, years	57.5 ± 8.8	55.6 ± 8.4	58.6 ± 9.0	61.3 ± 8.1	<0.001 ^a
Male, n (%)	348 (53.4)	187 (53.6)	102 (52.3)	59 (54.6)	0.92 ^b
Right eye, n (%)	344 (52.8)	—	—	—	—
Diabetes, n (%)	446 (68.4)	349 (100)	—	—	—
HbA1c, % (diabetics)	8.5 ± 1.4	—	—	—	—
Diabetes duration, years	10.9 ± 4.8	—	—	—	—
Hypertension, n (%)	400 (61.3)	—	—	—	—
Phakic, n (%)	469 (71.9)	—	—	—	—
Prior laser, n (%)	129 (19.8)	—	—	—	—
Edema duration, months	5.1 ± 3.6	5.1 ± 3.7	4.7 ± 3.1	5.5 ± 4.0	—
BCVA, logMAR	0.80 ± 0.23	0.78 ± 0.22	0.73 ± 0.21	0.99 ± 0.21	<0.001 ^a
CMT, μm	484.5 ± 118.9	453.0 ± 102.7	477.5 ± 105.2	598.8 ± 123.1	<0.001 ^a
IOP, mmHg	15.2 ± 2.2	15.1 ± 2.2	15.2 ± 2.1	15.4 ± 2.3	0.59 ^a

Data are mean $\pm$ SD or n (%). Superscripts: a, Kruskal–Wallis; b, chi-square. DME diabetic retinopathy grades: mild NPDR, 49 (14.0%); moderate NPDR, 145 (41.5%); severe NPDR, 83 (23.8%); PDR, 72 (20.6%).

Anatomical, visual and pressure outcomes

Overall mean CMT declined from $484.5 \pm 118.9 \mu\text{m}$ at baseline to $326.4 \pm 98.8 \mu\text{m}$ at month 1, an absolute reduction of $158.1 \mu\text{m}$ (32.6% relative to the rounded baseline mean). At month 3, CMT was $359.9 \pm 110.1 \mu\text{m}$, $124.6 \mu\text{m}$ below baseline (25.7% relative to the rounded baseline mean), although it had increased by $33.5 \mu\text{m}$ compared with month 1. The mean within-eye percentage CMT reduction at month 3 was $25.5 \pm 14.1\%$.

Mean BCVA improved from 0.80 ± 0.23 logMAR at baseline to 0.67 ± 0.26 at month 1 and 0.69 ± 0.27 at month 3. The mean paired BCVA gain at month 3 was 0.12 ± 0.11 logMAR. Mean IOP increased from 15.2 ± 2.2 mmHg at baseline to 17.4 ± 3.8 mmHg at month 1 and 16.6 ± 3.3 mmHg at month 3. All three measurements varied across follow-up (Friedman $p < 0.001$). Pairwise Wilcoxon comparisons for the overall cohort yielded $p < 0.001$ for baseline versus month 1, baseline versus month 3 and month 1 versus month 3 for each measure (Table 2 and Figure 1).

Table 2. BCVA, CMT and IOP at baseline and follow-up

Outcome	Group	Baseline	1 month	3 months	p (Friedman)
BCVA, logMAR	All	0.80 ± 0.23	0.67 ± 0.26	0.69 ± 0.27	<0.001
	DME	0.78 ± 0.22	0.65 ± 0.24	0.66 ± 0.25	<0.001
	BRVO	0.73 ± 0.21	0.59 ± 0.24	0.61 ± 0.25	<0.001
	CRVO	0.99 ± 0.21	0.89 ± 0.24	0.91 ± 0.25	<0.001

Outcome	Group	Baseline	1 month	3 months	p (Friedman)
CMT, μm	All	484.5 $\pm$ 118.9	326.4 $\pm$ 98.8	359.9 $\pm$ 110.1	<0.001
	DME	453.0 $\pm$ 102.7	306.5 $\pm$ 86.7	339.2 $\pm$ 97.1	<0.001
	BRVO	477.5 $\pm$ 105.2	318.6 $\pm$ 88.8	348.8 $\pm$ 99.8	<0.001
	CRVO	598.8 $\pm$ 123.1	404.7 $\pm$ 113.9	446.5 $\pm$ 125.9	<0.001
IOP, mmHg	All	15.2 $\pm$ 2.2	17.4 $\pm$ 3.8	16.6 $\pm$ 3.3	<0.001
	DME	15.1 $\pm$ 2.2	17.7 $\pm$ 4.1	16.6 $\pm$ 3.5	<0.001
	BRVO	15.2 $\pm$ 2.1	16.8 $\pm$ 3.1	16.3 $\pm$ 3.0	<0.001
	CRVO	15.4 $\pm$ 2.3	17.5 $\pm$ 3.6	17.0 $\pm$ 3.0	<0.001

Data are mean $\pm$ SD. The final column contains the Friedman p-value across the three visits. BCVA is expressed in logMAR (lower is better).

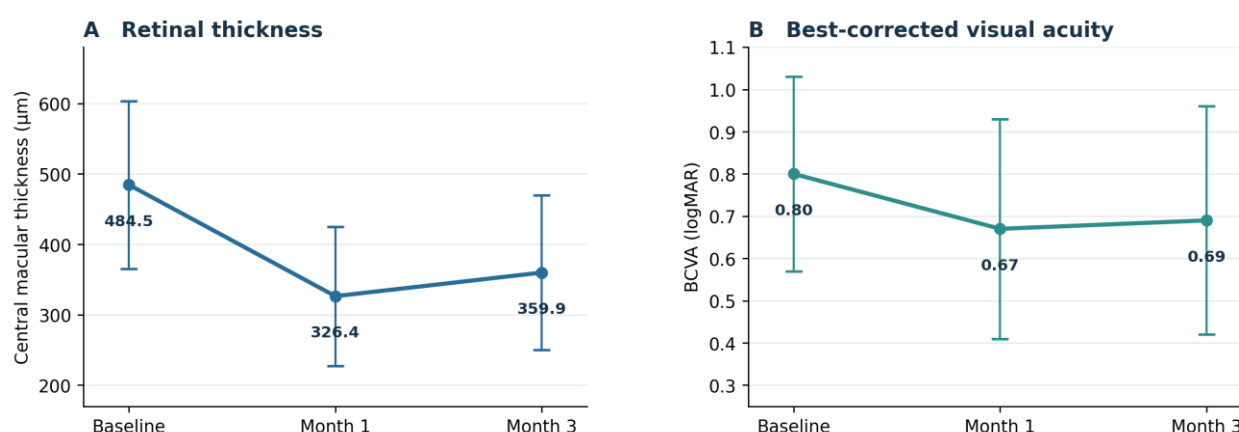


Figure 1. Overall cohort trajectories for (A) CMT and (B) BCVA at baseline, month 1 and month 3. Symbols represent reported means, and error bars represent reported SDs; they are not CIs for paired changes.

The mean patient-level percentage CMT reduction at month 3 was 24.9% in DME, 26.7% in BRVO and 25.2% in CRVO (between-group $p = 0.17$). Mean BCVA improvement at month 3 was smaller in CRVO (0.09 logMAR) than in DME and BRVO (0.12 logMAR each; $p = 0.014$). CMT reduction and BCVA improvement showed a positive rank correlation (Spearman $\rho = 0.31$, $p < 0.001$). These comparisons should be interpreted in the context of differing baseline disease severity.

Response, reinjection and adverse events

At month 3, 475 of 652 eyes met the predefined anatomical response criterion (72.9%; Wilson 95% CI 69.3–76.1%), and 156 eyes gained at least two BCVA lines (23.9%; 95% CI 20.8–27.3%). Any vision gain was reported in 555 eyes (85.1%); four eyes (0.6%) lost at least two lines. Repeat SCTA injection for persistent or recurrent edema occurred in 185 eyes (28.4%; 95% CI 25.0–32.0%), with the greatest reported frequency in CRVO (43.5%; Table 3 and Figure 2).

Elevated IOP >21 mmHg occurred in 89 eyes (13.7%; 95% CI 11.2–16.5%) and antiglaucoma drops were required in 55 (8.4%; 95% CI 6.5–10.8%). IOP elevation was more frequent in DME (17.2%) than BRVO (7.2%) or CRVO (13.9%; chi-square $p = 0.005$). Cataract progression was reported in 34 of 469 phakic eyes (7.2%); subconjunctival hemorrhage occurred in 79 eyes (12.1%). No endophthalmitis or retinal detachment occurred. Procedural pain was absent in 393 eyes (60.3%), mild in 221 (33.9%) and moderate in 38 (5.8%); the maximum recorded IOP was 35 mmHg.

Table 3. Anatomical and functional response, retreatment and ocular adverse events

Outcome	All (n = 652)	DME (n = 349)	BRVO (n = 195)	CRVO (n = 108)	p (chi-square)
Anatomical response (CMT $\downarrow$ $\geq 20\%$)	475 (72.9)	255 (73.1)	145 (74.4)	75 (69.4)	0.65

Outcome	All (n = 652)	DME (n = 349)	BRVO (n = 195)	CRVO (n = 108)	p (chi-square)
BCVA gain ≥ 2 lines	156 (23.9)	85 (24.4)	51 (26.2)	20 (18.5)	0.32
Reinjection by 3 months	185 (28.4)	87 (24.9)	51 (26.2)	47 (43.5)	<0.001
IOP >21 mmHg	89 (13.7)	60 (17.2)	14 (7.2)	15 (13.9)	0.005
Antiglaucoma drops needed	55 (8.4)	43 (12.3)	6 (3.1)	6 (5.6)	<0.001
Cataract progression (phakic eyes)	34/469 (7.2)	20/252 (7.9)	6/137 (4.4)	8/80 (10.0)	—
Subconjunctival haemorrhage	79 (12.1)	43 (12.3)	22 (11.3)	14 (13.0)	0.90
Endophthalmitis	0	0	0	0	—
Retinal detachment	0	0	0	0	—

Values are n (%) unless otherwise stated. Cataract progression uses phakic-eye denominators (469 overall; 252 DME, 137 BRVO and 80 CRVO). P-values represent chi-square comparisons across diagnostic subgroups.

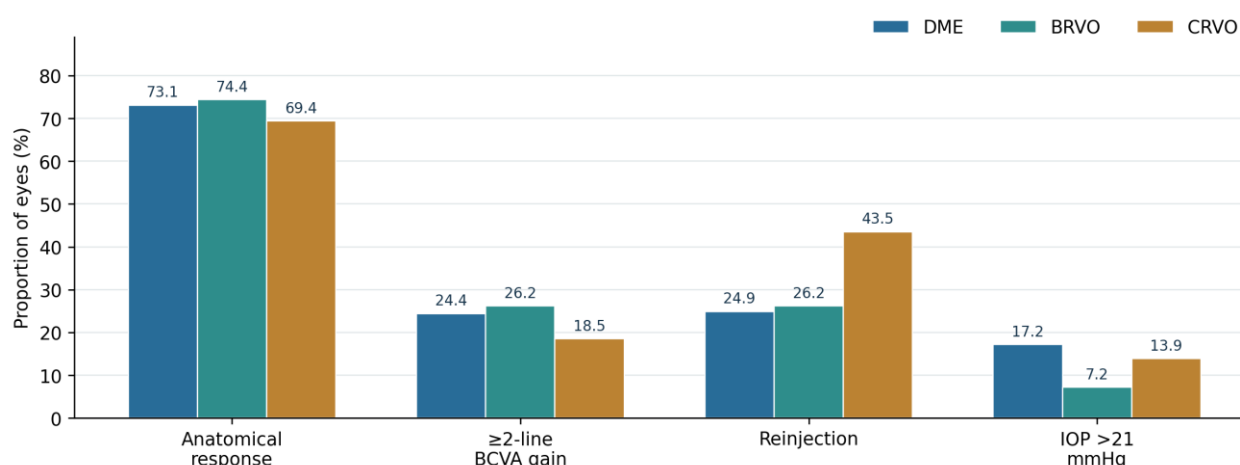


Figure 2. Proportions of eyes with anatomical response, ≥ 2 -line BCVA improvement, repeat injection and IOP >21 mmHg, stratified by diagnosis. All bars use observed group frequencies from Table 3.

DISCUSSION

In this prospective, single-arm cohort, SCTA administration was followed by significant improvements in retinal thickness and visual acuity at 1 month, with some loss of the initial improvement by month 3. The mean CMT reduction at month 1 was 158.1 μm , while the month-3 reduction was 124.6 μm relative to baseline. Functional improvement was more modest: approximately one line on average at 3 months, despite substantial anatomical change. A moderate positive association between reduction in CMT and improvement in BCVA supports the clinical relevance of edema resolution, but also suggests that retinal thickness alone does not fully explain visual outcome.

The pattern is compatible with smaller SCTA studies in retinal vascular macular edema. In a 2023 RVO pilot study, Ali and colleagues observed improvement in BCVA and a decline in central retinal thickness after suprachoroidal triamcinolone, with some attenuation by 3 months (6). In DME, Zakaria and colleagues compared suprachoroidal with intravitreal triamcinolone and reported early CMT reduction after 4-mg suprachoroidal dosing; the degree and durability of response varied among groups (7). A Pakistani study of resistant DME likewise reported anatomical and functional improvement after SCTA at 1 and 3 months (8). Differences in eligibility criteria, baseline severity, co-interventions and outcome definitions limit direct numerical comparisons.

The CRVO group began with greater mean CMT and worse visual acuity and showed a lower reported BCVA gain than the DME and BRVO groups. Retreatment was also more frequent in CRVO. Venous obstruction and associated ischemic injury may contribute to persistent edema and constrain visual recovery; however, these are plausible explanations rather than mechanisms directly established by this dataset (2). Further, results at month 3 reflect the actual course of care, including reinjection in a subset, and should not be interpreted as the isolated effect of a single injection.

Ocular corticosteroid safety requires attention. Elevated follow-up IOP occurred in 13.7% of treated eyes and topical pressure-lowering medication in 8.4%, underscoring the need for IOP monitoring despite the posterior distribution rationale of suprachoroidal delivery (3,4). PEACHTREE provides randomized evidence for SCTA in uveitic macular edema, but that indication is distinct from the vascular disorders evaluated here (5). The present series has no intravitreal-steroid or anti-VEGF comparator and therefore cannot establish a lower rate of complications or greater efficacy than alternative treatments. The short follow-up also limits interpretation of delayed cataract and glaucoma outcomes.

STUDY LIMITATIONS

The uncontrolled, single-center case-series design limits causal attribution and comparative efficacy conclusions. DME, BRVO and CRVO differ in natural history and baseline disease severity, and subgroup comparisons can be affected by these differences. The 3-month follow-up primarily describes short-term response and may not capture later recurrence, cumulative retreatment or long-term corticosteroid complications. In addition, the reinjections reported during follow-up complicate interpretation of changes as outcomes of the initial injection alone. These limitations support cautious interpretation and the need for controlled, longer-term studies.

CONCLUSION

In eyes with DME-, BRVO- and CRVO-associated macular edema, SCTA was associated with reduced CMT and improved BCVA over 3 months, with the greatest mean anatomical and visual improvement at month 1. Retreatment for persistent or recurrent edema and corticosteroid-associated IOP elevation were clinically relevant. Controlled studies with longer follow-up are needed to establish comparative efficacy and durability.

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