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ANATOMICAL AND FUNCTIONAL SUCCESS OF MACULAR EDEMA USING SUPRACHOROIDAL TRIAMCINOLONE ACETONIDE IN RETINAL VEIN OCCLUSION

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ABSTRACT

Background and Objective: Retinal vein occlusion is one of the leading causes of vision loss due to macular edema. Current treatment strategies primarily rely on anti-vascular endothelial growth factor therapy and intravitreal corticosteroids. However, repeated injections and steroid related complications remain major concerns. Suprachoroidal delivery of triamcinolone acetonide is an emerging therapeutic approach that allows targeted drug delivery to the posterior segment while reducing anterior segment exposure. The objective of this study was to evaluate the anatomical and functional success of suprachoroidal triamcinolone acetonide in patients with macular edema secondary to retinal vein occlusion.

Materials and Methods: This prospective interventional study was conducted at the Department of Ophthalmology, Sir Ganga Ram Hospital Lahore. Twenty-five eyes of twenty-five patients with macular edema secondary to retinal vein occlusion were included. Patients received suprachoroidal injection of triamcinolone acetonide and were followed for six months. Primary outcome measures included change in central macular thickness measured by optical coherence tomography and improvement in best corrected visual acuity. Secondary outcomes included changes in intraocular pressure and safety profile.

Results: Mean baseline central macular thickness was 561 ± 90 µm which significantly decreased to 261 ± 58 µm at six months. Mean best corrected visual acuity improved from 0.83 ± 0.21 logMAR at baseline to 0.30 ± 0.16 logMAR at final follow up. A gain of three or more lines of vision was observed in the majority of eyes. Intraocular pressure remained stable during follow up with no significant elevation. No serious ocular complications were recorded.

Conclusion: Suprachoroidal triamcinolone acetonide demonstrated significant anatomical and functional improvement in macular edema secondary to retinal vein occlusion with a favorable safety profile. The targeted delivery technique may reduce treatment burden and minimize steroid related complications.

KEYWORDS: Retinal vein occlusion, Macular edema, Suprachoroidal injection

INTRODUCTION

Retinal vein occlusion is the second most common retinal vascular disorder after diabetic retinopathy and represents a major cause of visual impairment worldwide[1]. The condition occurs due to obstruction of the retinal venous circulation which leads to increased venous pressure, retinal hemorrhages, and ischemic injury to retinal tissues[2]. Depending on the location of venous obstruction, retinal vein occlusion is classified into branch retinal vein occlusion and central retinal vein occlusion. Branch retinal vein occlusion involves blockage of a retinal venous branch and usually affects a localized area of the retina, whereas central retinal vein occlusion results from thrombosis of the central retinal vein and may cause more extensive retinal damage[3].

Macular edema is the most common cause of vision loss in retinal vein occlusion. The pathogenesis of macular edema involves breakdown of the blood retinal barrier and increased vascular permeability which results in accumulation of extracellular fluid within the retinal layers[4]. Hypoxia induced expression of vascular endothelial growth factor and other inflammatory mediators plays a critical role in the development and persistence of macular edema[5]. Optical coherence tomography has become the standard imaging modality for evaluating macular edema because it allows accurate measurement of central macular thickness and enables objective monitoring of treatment response[6].

Anti-vascular endothelial growth factor therapy has revolutionized the management of macular edema secondary to retinal vein occlusion. Agents such as ranibizumab, bevacizumab, and aflibercept have demonstrated significant improvement in visual acuity and reduction in retinal thickness in several clinical trials[7–8]. However, these therapies often require repeated injections over a prolonged period which increases treatment burden and healthcare costs. In addition, a subset of patients shows incomplete response or recurrence of edema after treatment[9].

Corticosteroids represent an alternative treatment option due to their anti-inflammatory properties and ability to stabilize the blood retinal barrier. Intravitreal triamcinolone acetonide and dexamethasone implants have been used to treat macular edema associated with retinal vein occlusion with encouraging results[10]. Nevertheless, intravitreal steroid therapy is associated with potential complications including cataract progression and steroid induced ocular hypertension[11].

The suprachoroidal space has recently gained attention as a promising route for targeted drug delivery to the posterior segment of the eye. This potential space lies between the sclera and the choroid and allows direct access to the choroid and retina[12]. Suprachoroidal injection enables high drug concentrations in posterior segment tissues while minimizing exposure to anterior segment structures such as the lens and trabecular meshwork[13]. Experimental and clinical studies have demonstrated that suprachoroidal administration of triamcinolone acetonide achieves effective drug levels within retinal tissues and provides sustained therapeutic effects[14]. The targeted delivery approach may also reduce the risk of steroid related adverse effects compared with conventional intravitreal injection[15].

Although recent studies have reported promising outcomes with suprachoroidal corticosteroid therapy in retinal diseases such as uveitic and diabetic macular edema, clinical data regarding its effectiveness in retinal vein occlusion remain limited[16]. Therefore, this study was conducted to evaluate the anatomical and functional outcomes of suprachoroidal triamcinolone acetonide injection in patients with macular edema secondary to retinal vein occlusion.

MATERIALS AND METHODS

This prospective interventional study was conducted at the Department of Ophthalmology, Sir Ganga Ram Hospital Lahore after approval from the institutional ethical review committee. Patients diagnosed with macular edema secondary to retinal vein occlusion were recruited for the study after obtaining informed consent.

A total of twenty-five eyes of twenty-five patients were included. Patients aged between forty and seventy-five years with clinical and optical coherence tomography evidence of macular edema secondary to branch retinal vein occlusion or central retinal vein occlusion were eligible for inclusion. Macular edema was defined as central macular thickness greater than 300 μm on spectral domain optical coherence tomography[14].

Patients with other retinal pathologies such as diabetic retinopathy, age related macular degeneration, or uveitis were excluded. Eyes with previous intraocular surgery within the last three months, history of glaucoma, or prior intravitreal steroid injection were also excluded from the study. A detailed ophthalmic examination was performed for each patient including measurement of best corrected visual acuity using Snellen charts, slit lamp examination, intraocular pressure measurement by applanation tonometry, and dilated fundus examination. Optical coherence tomography imaging was performed to measure central macular thickness.

Suprachoroidal injection of triamcinolone acetonide was performed under aseptic conditions in the operating room. A specially designed micro needle was used to deliver a prepared dose of 0.1 ml (4 mg) of triamcinolone acetonide approximately four millimeters posterior to the limbus in the superotemporal quadrant[15].The needle was inserted perpendicular to the scleral surface, traversing approximately 1 mm of scleral tissue to access the suprachoroidal space.In cases where central retinal artery occlusion is detected, anterior chamber paracentesis is performed using a 30-gauge insulin syringe. Finally, a single drop of a topical fluoroquinolone antibiotic is instilled to prevent infection.[5] Patients were monitored for immediate complications following the procedure. Patients were asked to remove the pads from eye after two hours of the procedure in an indoor and clean environment. Post injection follow up is scheduled for second day and 1 week. Patients were instructed to immediately report any post-injection complications, including redness, pain, or any decrease in vision. Post-treatment follow-up visits were scheduled at two months after injection. During each visit patients underwent measurement of visual acuity, optical coherence tomography imaging to evaluate changes in macular thickness and intraocular pressure assessment. Injections were administered until either a best-corrected visual acuity (BCVA) of log-MAR 0.00 or a central macular thickness (CMT) of 250 μm is achieved, or until a maximum of 3 injections have been administered—whichever occurred first.

The primary outcome measures of the study included reduction in central macular thickness and improvement in best corrected visual acuity. Secondary outcomes included changes in intraocular pressure and occurrence of any treatment related complications. However, finding the underlying causes of CRVO and BRVO and association to the hypertension is not in the scope of this research. Data were analyzed using statistical software. Continuous variables were expressed as mean and standard deviation while categorical variables were presented as frequencies and percentages. Paired t test was used to compare baseline and follow up measurements. A p-value less than 0.05 was considered statistically significant.

RESULTS AND ANALYSIS

A total of twenty five eyes of twenty five patients with macular edema secondary to retinal vein occlusion were included in the study. Among these cases, sixteen eyes were diagnosed with branch retinal vein occlusion while nine eyes had central retinal vein occlusion.

The mean age of the participants was 58.2 ± 10.8 years, with the majority of patients falling within the age group of 50 to 70 years. This distribution corresponds with global epidemiological patterns of retinal vein occlusion, which predominantly affects older adults with systemic vascular risk factors. Male patients constituted 15 cases

(60 percent) while female patients accounted for 10 cases (40 percent). Branch retinal vein occlusion was the most frequently observed subtype and was identified in 16 eyes (64 percent), whereas central retinal vein occlusion was present in 9 eyes (36 percent).

The right eye was affected in 14 patients (56 percent) and the left eye in 11 patients (44 percent). At baseline, the mean best corrected visual acuity was 0.83 ± 0.21 logMAR. The mean central macular thickness measured using spectral domain optical coherence tomography was 561 ± 90 µm. The mean baseline intraocular pressure was 14.6 ± 2.2 mmHg. All the baseline statistics are presented in the Table 1.

Table 1: Baseline demographic and clinical characteristics

Variable	Category	Frequency / Mean ± SD	Percentage
Total patients	–	25	–
Total study eyes	–	25	–
Age (years)	Mean ± SD	58.2 ± 10.8	–
Gender	Male	15	60%
	Female	10	40%
Type of RVO	BRVO	16	64%
	CRVO	9	36%
Eye involved	Right	14	56%
	Left	11	44%
Baseline BCVA (logMAR)	Mean ± SD	0.83 ± 0.21	–
Baseline CMT (µm)	Mean ± SD	561 ± 90	–
Baseline IOP (mmHg)	Mean ± SD	14.6 ± 2.2	–

Suprachoroidal triamcinolone acetonide demonstrated a significant reduction in central macular thickness during the follow up period. The mean central macular thickness decreased from 561 ± 90 µm at baseline to 376 ± 74 µm at two months. Further reduction was observed at four months where the mean thickness decreased to 294 ± 66 µm. At the final follow up at six months, the mean central macular thickness was 261 ± 58 µm.

The overall reduction in retinal thickness from baseline to final follow up was approximately 300 µm, representing nearly a 53 percent decrease in macular edema. Statistical analysis using paired t testing demonstrated that the reduction in central macular thickness was highly significant with a p value less than 0.001. The changes in central macular thickness are summarized in Table 2. The graphical representation of reduction in retinal thickness is presented in Figure 1 along with standard deviation error bars.

Table 2: Changes in central macular thickness

Time point	Mean CMT (µm)	Standard deviation	Mean reduction from baseline	P value
Baseline	561	90	–	–
2 months	376	74	185	<0.001
4 months	294	66	267	<0.001
6 months	261	58	300	<0.001

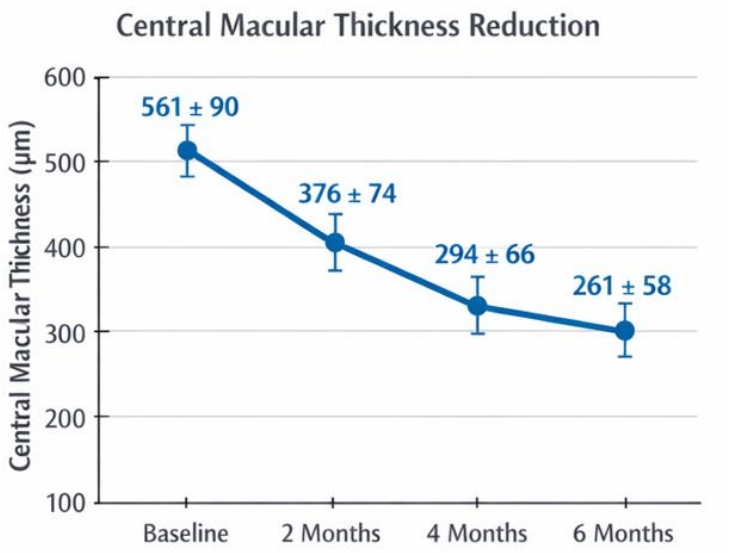


Figure 1: Reduction in Central Macular Thickness (CMT) over six months following suprachoroidal triamcinolone acetonide injection. Mean CMT decreased from 561 ± 90 µm at baseline to 261 ± 58 µm at six months, indicating significant anatomical improvement in macular edema. Error bars represent standard deviation.

It can be observed in Figure 1, that the highest reduction in retinal thickness occurred during the first two months after treatment, indicating a rapid anatomical response to corticosteroid therapy.

Visual acuity improved progressively during the follow up period. The mean best corrected visual acuity improved from 0.83 ± 0.21 logMAR at baseline to 0.57 ± 0.19 logMAR at two months. Continued improvement was observed at four months where the mean BCVA reached 0.39 ± 0.17 logMAR. At six months the mean visual acuity improved further to 0.30 ± 0.16 logMAR. Overall, the mean improvement from baseline to final follow up was 0.53 logMAR. A gain of three or more lines of visual acuity was observed in the majority of eyes, indicating clinically meaningful functional improvement. The changes and improvement in best corrected visual acuity is presented in Table 3 and Figure 2.

Table 3: Changes in best corrected visual acuity

Time point	Mean BCVA (logMAR)	Standard deviation	Mean improvement	P value
Baseline	0.83	0.21	–	–
2 months	0.57	0.19	0.26	<0.001
4 months	0.39	0.17	0.44	<0.001
6 months	0.30	0.16	0.53	<0.001

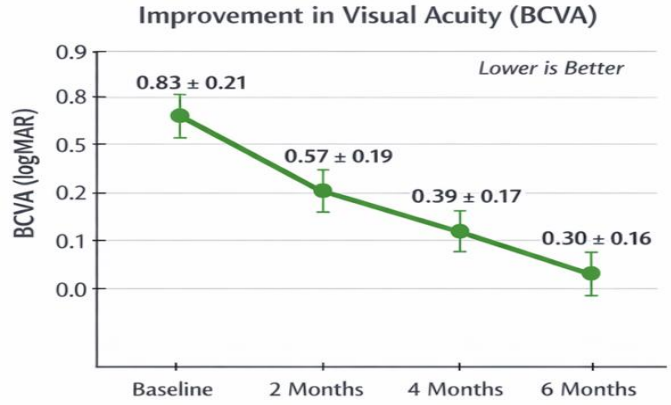


Figure 2: Improvement in Best Corrected Visual Acuity (BCVA) over six months post suprachoroidal triamcinolone acetonide treatment. Mean BCVA improved from 0.83 ± 0.21 logMAR at baseline to 0.30 ± 0.16 logMAR at six months, reflecting meaningful functional recovery. Error bars represent standard deviation.

Intraocular pressure remained stable during the follow up period as presented in Table 4 and Figure 3. The mean intraocular pressure increased slightly from 14.6 ± 2.2 mmHg at baseline to 15.4 ± 2.4 mmHg at six months. The observed change was not clinically significant.

Table 4: Changes in intraocular pressure

Time point	Mean IOP (mmHg)	Standard deviation	Change from baseline	P value
Baseline	14.6	2.2	–	–
2 months	14.9	2.3	+0.3	0.28
4 months	15.2	2.4	+0.6	0.11
6 months	15.4	2.4	+0.8	0.09

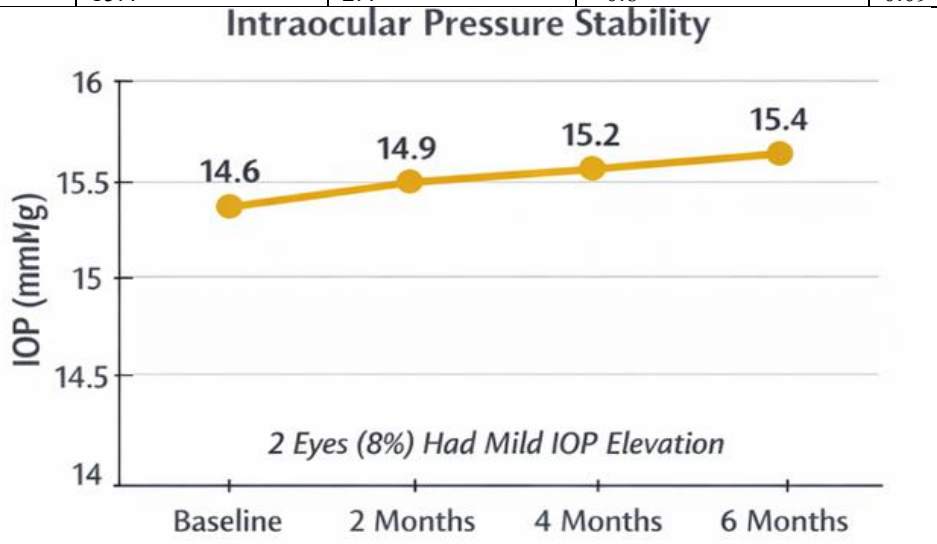


Figure 3: Intraocular pressure (IOP) stability during six months of follow-up. Mean IOP remained within normal range (14.6 mmHg at baseline to 15.4 mmHg at six months), with only 8% of eyes experiencing mild elevation controlled by topical medication, demonstrating a favourable safety profile.

Only two eyes (8 percent) experienced mild elevation of intraocular pressure which was successfully controlled with topical medication. No serious complications such as endophthalmitis, retinal detachment, or suprachoroidal hemorrhage were observed during the study period.
The number of suprachoroidal triamcinolone injections required varied among eyes. The mean number of injections required per eye was 1.76 ± 0.72, suggesting that suprachoroidal corticosteroid therapy may reduce treatment burden compared with repeated intravitreal anti VEGF injections. The detailed distribution of injections is presented in Table 5 and Figure 4.

Table 5: Distribution of injections administered

Number of injections per Eye	Number of eyes	Number of injections	Percentage
One injection	10	1 × 10 =10	40%
Two injections	11	2 × 11 =22	44%
Three injections	4	3 × 4 = 12	16%
Total	25	44	100%
Mean Number of Injections with standard deviation	1.76 ± 0.72		

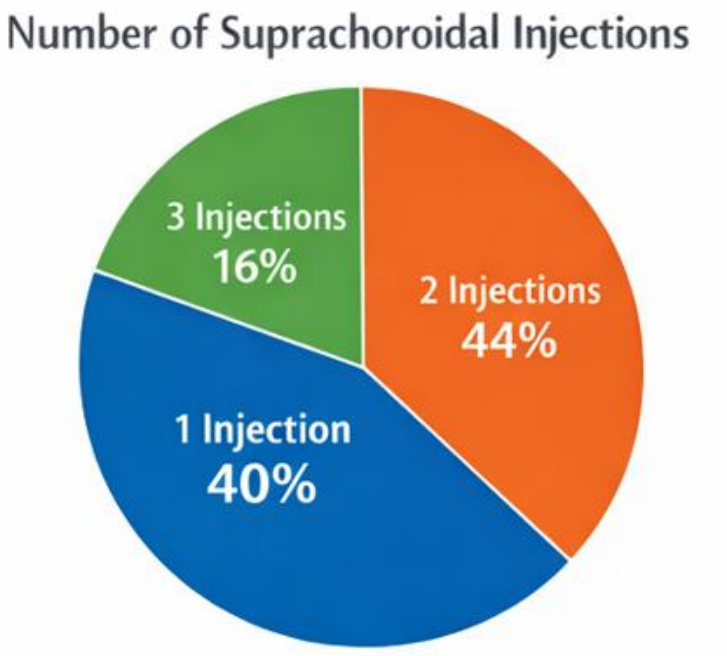


Figure 4: Distribution of the number of suprachoroidal triamcinolone injections administered per eye. Majority of patients required one or two injections (84%), suggesting a reduced treatment burden compared with repeated intravitreal anti-VEGF therapy.

The mean number of injections required per eye was 1.76 ± 0.72, suggesting that suprachoroidal corticosteroid therapy may reduce treatment burden compared with repeated intravitreal anti VEGF injections.
The results of the present study demonstrate that suprachoroidal triamcinolone acetonide provides significant anatomical and functional improvement in eyes with macular edema secondary to retinal vein occlusion. The marked reduction in central macular thickness observed during the follow up period corresponds with significant improvement in visual acuity. The treatment was well tolerated, with minimal changes in intraocular pressure and no major adverse events. These findings are consistent with recent clinical studies investigating targeted suprachoroidal drug delivery, which report improved retinal drug bioavailability with reduced anterior segment exposure. The results suggest that suprachoroidal triamcinolone acetonide represents an effective and safe therapeutic option for the management of macular edema associated with retinal vein occlusion.

DISCUSSION

The present study evaluated the anatomical and functional outcomes of suprachoroidal triamcinolone acetonide in patients with macular edema secondary to retinal vein occlusion. The findings demonstrated significant reduction in central macular thickness and meaningful improvement in visual acuity over the six month follow up period. These results support the growing evidence that targeted suprachoroidal corticosteroid delivery is an effective therapeutic option for retinal vascular diseases. Macular edema represents the major cause of vision loss in retinal vein occlusion and results primarily from increased vascular permeability mediated by vascular endothelial growth factor and inflammatory cytokines[16]. Traditional therapies such as intravitreal anti vascular endothelial growth factor injections have demonstrated significant benefits but require repeated administration and frequent monitoring[17]. In addition, some patients exhibit incomplete response which necessitates alternative

treatment approaches. In the present study mean central macular thickness decreased from 561 μm at baseline to 261 μm at six months, representing a substantial reduction in retinal edema. This magnitude of anatomical improvement is consistent with previously reported studies evaluating corticosteroid therapy for retinal vein occlusion associated macular edema[18]. The early reduction in retinal thickness observed within the first two months indicates a rapid therapeutic effect of suprachoroidal triamcinolone.

Visual acuity outcomes in this study also demonstrated significant improvement. Mean best corrected visual acuity improved from 0.83 logMAR at baseline to 0.30 logMAR at final follow up. A majority of eyes achieved a gain of three or more lines of vision which is generally considered a clinically meaningful improvement. These findings are comparable with outcomes reported in previous clinical trials of suprachoroidal corticosteroid therapy for retinal diseases[19]. The mechanism underlying the effectiveness of suprachoroidal triamcinolone acetonide is related to targeted drug delivery to the choroid and retina. Pharmacokinetic studies have shown that suprachoroidal administration results in higher drug concentrations within posterior segment tissues while minimizing exposure to anterior segment structures[20]. This selective distribution enhances therapeutic efficacy while reducing steroid related adverse effects. Another important advantage of suprachoroidal drug delivery is the potential reduction in treatment burden. Intravitreal anti vascular endothelial growth factor therapy often requires monthly injections during the initial treatment phase[21]. In contrast corticosteroid therapy may provide longer duration of action due to its anti-inflammatory effects and stabilization of the blood retinal barrier. In the present study the majority of eyes required only one or two injections during the follow up period which suggests a lower treatment frequency.

Safety outcomes in this study were also encouraging. Intraocular pressure remained stable throughout the follow up period and only a small proportion of eyes developed mild ocular hypertension which was controlled with topical medication. This observation is consistent with earlier studies which reported lower rates of steroid induced intraocular pressure elevation with suprachoroidal administration compared with intravitreal injection[22]. The lower incidence of steroid related complications may be explained by reduced exposure of the anterior segment to corticosteroids. Intravitreal injection allows diffusion of drug molecules toward the trabecular meshwork and lens which contributes to ocular hypertension and cataract formation[23]. Suprachoroidal injection primarily targets the posterior segment which limits drug distribution to these structures. Recent clinical trials have further supported the effectiveness of suprachoroidal triamcinolone acetonide in retinal diseases. Studies evaluating this therapy for uveitic macular edema have demonstrated significant improvement in visual acuity and reduction in retinal thickness with favorable safety profiles[24]. Similar outcomes have been reported in diabetic macular edema which suggests that the suprachoroidal route may be applicable to multiple retinal conditions[25]. Although the findings of the present study are promising certain limitations should be considered. The sample size was relatively small and the follow up period was limited to six months. Larger randomized controlled trials with longer follow up are required to confirm the long-term effectiveness and safety of suprachoroidal triamcinolone therapy in retinal vein occlusion.

Despite these limitations the results provide important clinical evidence supporting the use of suprachoroidal corticosteroid delivery for macular edema secondary to retinal vein occlusion. The combination of significant anatomical improvement, visual acuity gain, and favorable safety profile highlights the potential of this technique as an alternative or adjunct to existing therapies.

CONCLUSION

Macular edema remains the principal cause of visual impairment in patients with Retinal Vein Occlusion. This study demonstrated that suprachoroidal triamcinolone acetonide produced significant anatomical and functional improvement in affected eyes. Central macular thickness showed a consistent and progressive reduction on optical coherence tomography from baseline to six months of follow up. These anatomical improvements were accompanied by meaningful gains in best corrected visual acuity, with many eyes achieving an improvement of three or more lines. The close association between reduced retinal thickness and visual recovery highlights the effectiveness of this treatment approach for macular edema. The safety profile observed in this study was favorable. Intraocular pressure remained stable throughout the follow up period and no major treatment related complications were detected. Corticosteroid induced ocular hypertension is a known concern with intravitreal steroid therapy. However, the targeted drug delivery through the suprachoroidal route appears to limit exposure of anterior segment structures, which may explain the minimal intraocular pressure changes observed. Comparison between branch and central types showed slightly better visual outcomes in eyes with branch involvement, which is consistent with previously reported clinical patterns. Despite these encouraging findings, certain limitations must be acknowledged. The sample size was relatively small and the duration of follow up was limited to six months. Furthermore, identifying the underlying causes of central and branch retinal vein occlusion and exploring any potential association with hypertension were beyond the scope of this research.

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