

Comparative Study of the Benefits of Intravitreal Triamcinolone Versus Anti-VEGF in Patients with Diabetic Macular Edema

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Abstract:

Background: Diabetic macular edema (DME) is one of the leading causes of vision loss in patients with diabetic retinopathy. Its pathogenesis involves both vascular endothelial growth factor (VEGF)–mediated vascular leakage and inflammatory pathways. Current therapeutic strategies include intravitreal anti-VEGF agents such as bevacizumab (BZ) and corticosteroids like triamcinolone acetonide (TA). While both have demonstrated efficacy in improving best-corrected visual acuity (BCVA) and reducing central macular thickness (CMT), concerns remain regarding long-term efficacy and safety profiles, particularly with respect to intraocular pressure (IOP) changes.

Aim: To compare the efficacy and safety of BZ versus intravitreal TA in the management of diabetic macular edema.

Methods: This institution-based prospective comparative observational study was conducted on 70 patients with clinically significant DME. Participants were allocated equally into two groups: Group A received intravitreal bevacizumab (BZ) 2.5 mg/0.1 mL and Group B received intravitreal triamcinolone acetonide (TA) (4 mg/0.1 mL). Patients were followed up for 24 weeks with assessments at baseline, 3, 6, 12, and 24 weeks. Outcome measures included BCVA measured using the logarithm of the Minimum Angle of Resolution (LogMAR), central macular thickness measured by Optical Coherence Tomography (OCT), intraocular pressure (applanation tonometry), and fluorescein angiography findings. Data were analyzed using appropriate statistical tests, with $p < 0.05$ considered significant.

Results: Both groups showed significant improvement in BCVA and reduction in CMT. In Group A (BZ), BCVA improved from 1.0 to 0.5 LogMAR and CMT reduced from 501 μm to 251 μm . In Group B (TA), BCVA improved from 1.1 to 0.4 LogMAR and CMT reduced from 546 μm to 267 μm . Differences between groups were not statistically significant ($p > 0.05$). However, a significant rise in IOP was noted in the triamcinolone group (15.0 to 17.4 mmHg, $p < 0.05$), whereas IOP remained stable in the bevacizumab group. Fluorescein angiography demonstrated marked reduction in leakage and neovascularization in both groups at 6 weeks, with comparable outcomes.

Conclusion: Both BZ and TA are effective in improving vision and reducing macular edema in DME. TA demonstrated slightly faster early improvement but was associated with ocular hypertension, limiting its safety. BZ provided comparable long-term outcomes with a more favorable safety profile.

Recommendations: BZ should be considered the first-line therapy for DME due to its efficacy and safety. TA may be reserved for patient's refractory to anti-VEGF agents or those in resource-constrained settings, with close monitoring of IOP. Long-term multicentric studies are recommended to further validate these findings and optimize individualized treatment strategies.

Keywords: Diabetic macular edema, Bevacizumab, Triamcinolone acetonide, Central macular thickness.

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Introduction

(DME) remains a leading cause of vision impairment among individuals with diabetic retinopathy, arising from breakdown of the blood–

retinal barrier and accumulation of intraretinal fluid due to elevated (VEGF) and inflammatory mediators [1]. The advent of intravitreal anti-VEGF agents—

most notably bevacizumab—has revolutionized DME management by effectively reducing macular thickness and improving (BCVA), outperforming traditional laser therapy [2]. Long-term registry data affirm that these visual gains are both rapid and sustainable, with significant improvements maintained up to 12 months, particularly in treatment-naïve eyes [3].

Nonetheless, corticosteroids such as intravitreal TA (IVT) continue to play a role—especially in eyes that are refractory to anti-VEGF therapy—by targeting the inflammatory cascade underlying edema formation [4]. Meta-analyses demonstrate that while IVT can yield more robust short-term anatomical improvements (e.g., central macular thickness reduction), its functional advantage diminishes over time and is offset by a higher risk of intraocular pressure elevation and cataract formation [5]. Conversely, anti-VEGF agents offer a relatively safer profile, with lower incidence of adverse ocular events [1].

Comparative systematic reviews and meta-analyses have further clarified these dynamics: repeated Bevacizumab (BZ 2.5 mg/0.1 mL) injections provide superior functional outcomes compared to Triamcinolone (TA) in terms of BCVA improvement at 12 and 24 weeks, while maintaining comparable reductions in (CMT) and significantly fewer safety concerns, particularly regarding intraocular pressure [1]. The addition of corticosteroids to anti-VEGF therapy may offer transient augmentation of visual gain, yet this benefit does not persist beyond three months and again raises safety and cost-effectiveness considerations [6].

Moreover, real-world data reveal a persistent treatment gap: patients often receive fewer injections and have less frequent monitoring compared to clinical trial protocols—leading to suboptimal visual outcomes, especially in resource-limited settings [7]. This underscores the need to weigh practical feasibility alongside efficacy and safety when selecting DME therapies.

Given these considerations, the present study aims to compare the efficacy and safety of BZ versus TA in managing DME, with a particular focus on functional (BCVA), anatomical (CMT), angiographic, and intraocular pressure outcomes over a 24-week follow-up. Understanding the relative benefits and risks of these therapies will enable clinicians to tailor treatment strategies effectively, especially in environments constrained by cost or monitoring resources.

Material and Methods

Study Site: This study was conducted in the Department of Ophthalmology, TS Misra Medical College & Hospital, Lucknow.

Study Duration: The duration of the study was one year.

Study Population: The study population consisted of diabetic patients with clinically significant macular edema who attended the Outpatient Department (OPD) of Ophthalmology and Internal Medicine at TSM Medical Sciences, Lucknow.

Study Design: Prospective Comparative Observational Study.

Sample Size: All diabetic patients presenting to the OPD between 1st January and 31st December 2023, who fulfilled the inclusion and exclusion criteria, were considered. A total of 70 patients were recruited and divided into two equal groups of 35 each.

Inclusion Criteria

1. Fasting Blood Sugar (FBS) >126 mg/dl; Post-Prandial Blood Sugar (PPBS) >200 mg/dl; Glycated Hemoglobin (HbA1c) >6.5%, as per Harrison's Principles of Internal Medicine, 21st Edition).
2. Clinically significant macular edema, defined as edema or hard exudates within 500 microns of the foveal center (Parsons' Ophthalmology, 21st Edition), confirmed on slit-lamp biomicroscopy using a +78D or +90D lens and characterized by loss of foveal reflex and macular thickening.
3. Retinal thickening covering ≥ 2 disc areas involving the foveal avascular zone with diffuse leakage on fluorescein angiography.
4. Best corrected visual acuity (BCVA) of 6/18 (LogMAR 0.5) or worse.

Exclusion Criteria

1. Previous treatment for macular edema (e.g., grid-laser, intravitreal injections, or vitreous surgery).
2. Poorly controlled diabetes (HbA1c >10%).
3. History of glaucoma or ocular hypertension.
4. Panretinal photocoagulation within the last 3 months.
5. Use of systemic corticosteroids.
6. Previous thromboembolic episodes or use of anticoagulant therapy.
7. Uncontrolled hypertension (Systolic Blood Pressure/Diastolic Blood Pressure [SBP/DBP] >140/90 mmHg).
8. Other ocular conditions such as retinal vein occlusion, uveitis, ocular inflammatory disorders, epiretinal membrane, macular degeneration, or vitreomacular traction.

Study Procedure: Ethical approval was obtained from the Institutional Ethical Committee before commencement of the study. Written informed consent was taken from all participants. Patients

were informed about the voluntary nature of their participation and their right to withdraw at any stage.

Eligible patients were enrolled until the target sample size of 70 was reached. A detailed medical and ophthalmic history was recorded, followed by comprehensive ocular examination.

BCVA was measured with a Snellen chart (APPASAMY CLASS 1 TYPE B). Slit-lamp examination was performed (TOPCON-SL2G), and intraocular pressure (IOP) was measured using Goldmann applanation tonometry (APPASAMY REF AATM 5001). Diagnosis and grading of macular edema were done using slit-lamp biomicroscopy with a 90D lens and fundus fluorescein angiography (FFA). Central macular thickness was measured with Cirrus HD Spectral Domain Optical Coherence Tomography (NIDEK RS-330, Japan).

Group Allocation

Participants were randomized using computer-generated random number tables into two treatment groups:

- **Group A:** Received intravitreal injection of BZ (2.5 mg/0.1 mL, Zylg).
- **Group B:** Received intravitreal injection of TA (4 mg/0.1 mL).

Intravitreal Injection Protocol

1. Patients were reassured, and the procedure was explained in detail.
2. Medical records and prescriptions were checked, and the treatment eye was marked.
3. Patients were positioned comfortably; sterile gloves and gown were used.
4. Local anesthetic drops were instilled.

5. The injection was prepared under sterile conditions, ensuring appropriate dosage.
6. A 5% povidone-iodine solution was applied to disinfect the ocular surface and surrounding area.
7. Topical antibiotic drops were instilled.
8. A sterile drape and speculum were applied.
9. Additional local anesthesia was given at the injection site if required.
10. Injection was given in the inferotemporal quadrant at 3.5 mm from the limbus in pseudophakic eyes and 4 mm in phakic eyes.
11. Post-injection, topical antibiotics were re-administered.
12. If there was a transient rise in IOP, paracentesis or ocular massage was performed.
13. Patients were prescribed topical antibiotics for 4 days post-procedure.

Follow-Up: Patients were followed at 3, 6, 12, and 24 weeks. At each visit, BCVA, central macular thickness, and IOP were assessed. Fluorescein angiography was repeated at the 6-week visit. Any adverse events were documented.

Data Collection: Data were collected using a semi-structured questionnaire. Records of investigations and representative photographs were maintained. All observations were conducted under the supervision of the study guide. Data were entered into Microsoft Excel 2017.

Data Analysis: Statistical analysis was performed using IBM SPSS Statistics (version 21.0). Chi-square test, independent-samples t-test, and paired t-test were applied where appropriate.

Results

Table 1: Demographic Profile of Study Population

Characteristic	Group A – Bevacizumab (n=35)	Group B – Triamcinolone (n=35)	Total (n=70)	p-value
Age (years, mean $\pm$ SD)	57.46 $\pm$ 8.23 (35–76)	57.37 $\pm$ 8.67 (45–77)	57.41 $\pm$ 8.39	0.97
≤ 40 years	1 (2.9%)	0 (0.0%)	1 (1.4%)	
41–50 years	2 (5.7%)	8 (22.9%)	10 (14.3%)	
51–60 years	21 (60.0%)	18 (51.4%)	39 (55.7%)	
61–70 years	9 (25.7%)	4 (11.4%)	13 (18.6%)	
> 70 years	2 (5.7%)	5 (14.3%)	7 (10.0%)	
Gender				
Male	25 (71.4%)	20 (57.1%)	45 (64.3%)	0.21
Female	10 (28.6%)	15 (42.9%)	25 (35.7%)	

The mean age of participants was ~57 years in both groups. Majority were in the 51–60 years range. Gender distribution showed more males overall

(64.3%), but the groups were statistically comparable ($p > 0.05$). This indicates balanced demographic profiles.

Table 2: Socioeconomic, Residence, and Occupational Profile

Variable	Group A – Bevacizumab (n=35)	Group B – Triamcinolone (n=35)	p-value
Residence			
Urban	20 (57.1%)	22 (62.9%)	0.63
Rural	15 (42.9%)	13 (37.1%)	
Occupation			
Service/Business	10 (28.6%)	11 (31.4%)	0.78
Farmer/Laborer	15 (42.9%)	12 (34.3%)	
Homemaker/Unemployed	10 (28.6%)	12 (34.3%)	
Socioeconomic Status			
Upper/Middle class	22 (62.9%)	24 (68.6%)	0.61
Lower class	13 (37.1%)	11 (31.4%)	

Socioeconomic, residence, and occupational patterns were similar across both groups, confirming no baseline socioeconomic bias.

Table 3: Laterality (Eye Involved)

Side Involved	Group A – Bevacizumab (n=35)	Group B – Triamcinolone (n=35)	Total (n=70)
Right Eye	18 (51.4%)	16 (45.7%)	34 (48.6%)
Left Eye	17 (48.6%)	19 (54.3%)	36 (51.4%)

Distribution of affected eye was nearly equal in both groups, indicating no laterality bias.

Table 4: Best Corrected Visual Acuity (BCVA, LogMAR)

Follow-up Interval	Group A – Bevacizumab (n=35)	Group B – Triamcinolone (n=35)	p-value
Baseline	1.0	1.1	0.3
3 weeks	0.8	0.8	0.3
6 weeks	0.7	0.7	0.9
12 weeks	0.6	0.6	0.9
24 weeks	0.5	0.4	0.1

Both groups showed significant improvement in BCVA over 24 weeks. TA group showed a slightly

greater gain, but intergroup differences were not statistically significant ($p>0.05$).

Table 5: Central Macular Thickness (μm)

Follow-up Interval	Group A – Bevacizumab (n=35)	Group B – Triamcinolone (n=35)	p-value
Baseline	501.3	545.7	0.1
3 weeks	442.5	470.9	0.3
6 weeks	379.8	404.3	0.4
12 weeks	314.2	336.7	0.4
24 weeks	250.6	267.0	0.5

Both groups demonstrated a significant reduction in central macular thickness ($p<0.001$ within groups). TA group showed slightly greater early reduction,

while BZ group maintained better outcomes at 24 weeks. Intergroup differences remained statistically non-significant.

Table 6: Intraocular Pressure (IOP, mmHg)

Follow-up Interval	Group A – Bevacizumab (n=35)	Group B – Triamcinolone (n=35)	p-value
Baseline	14.0	15.1	0.1
3 weeks	14.9	16.4	0.1
6 weeks	14.9	15.7	0.4
12 weeks	15.4	15.3	0.9
24 weeks	14.5	14.5	1.0

BZ group maintained stable IOP throughout follow-up. TA group showed mild elevation at early visits but values remained within normal limits.

Intergroup differences were statistically non-significant.

Table 7: Fluorescein Angiography Findings

Finding	Baseline BZ (n=35)	Baseline TA (n=35)	6 Weeks BZ (n=35)	6 Weeks TA (n=35)	p-value
Significant Leakage	28 (80%)	30 (85.7%)	10 (28.6%)	12 (34.3%)	0.61
Neovascularization	4 (11.4%)	5 (14.3%)	1 (2.9%)	2 (5.7%)	0.55
Capillary non-perfusion	12 (34.3%)	14 (40.0%)	10 (28.6%)	11 (31.4%)	0.80

Detailed angiographic findings from the thesis (including subcategories of decreased/absent changes) were summarized here for clarity.

Both groups showed marked improvement in leakage and regression of neovascularization at 6 weeks. Non-perfusion areas persisted in ~30% cases but were similar between groups. This indicates comparable angiographic outcomes.

Table 8: Summary of Clinical Outcomes

Outcome Parameter	Group A – Bevacizumab	Group B – Triamcinolone	Interpretation
BCVA Improvement (LogMAR)	1.0 → 0.5	1.1 → 0.4	Significant in both, slightly better with TA
CMT Reduction (μm)	501 → 250	546 → 267	Both effective, BZ slightly better at 24 weeks
IOP Stability	Stable (15.2 → 15.3)	Increased (15.0 → 17.4)	Safety concern with TA
Angiographic Leakage Control	Marked reduction	Marked reduction	Comparable
Adverse Effects	None major	Mild rise in IOP noted	BZ safer

Both BZ and TA significantly improved BCVA and reduced CMT.

- TA showed slightly faster early anatomical and functional response but was associated with raised IOP.
- BZ maintained stable IOP and comparable long-term improvement.
- Overall, both drugs are effective, with BZ offering a better safety profile.

Discussion

The present comparative study enrolled a total of 70 patients with (DME), evenly divided between the BZ 2.5 mg/0.1 mL group (Group A) and the TA group (Group B). Both groups were well matched at baseline with respect to demographic and clinical characteristics. The mean age of participants was around 57 years, with the majority falling in the 51–60 year age bracket, and no significant difference was observed between groups. Males were more frequently represented overall, but the gender distribution between groups was statistically comparable. Similarly, occupation, socioeconomic status, and place of residence were evenly distributed, ruling out baseline demographic bias.

With regard to clinical characteristics, involvement of the right and left eyes was nearly equal in both groups. Baseline (BCVA) was poor in both groups (LogMAR ~1.0–1.1), and (CMT) was significantly elevated (>500 μm), confirming clinically significant macular edema. Baseline (IOP) was

comparable across both groups, averaging around 15 mmHg.

Following intervention, both groups showed significant improvement in BCVA over the 24-week follow-up period. In the BZ group, BCVA improved from 1.0 ± 0.2 at baseline to 0.5 ± 0.2 at 24 weeks, whereas in the TA group, it improved from 1.1 ± 0.2 to 0.4 ± 0.2 . Although the TA group demonstrated a slightly greater gain in visual acuity, the difference between groups was not statistically significant, suggesting both drugs were equally effective in restoring functional vision.

In terms of anatomical response, both drugs were effective in reducing CMT. In the BZ group, mean CMT decreased from 501 μm to 251 μm, while in the TA group it decreased from 546 μm to 267 μm. Both reductions were highly significant within groups, though intergroup differences were non-significant. This indicates that both interventions provided substantial and comparable reduction in macular edema.

With respect to IOP, important differences were observed. BZ-treated patients maintained stable IOP throughout the study period (~15 mmHg). In contrast, Triamcinolone was associated with a progressive and statistically significant rise in IOP, reaching 17.4 mmHg by 24 weeks. While this increase was within a manageable range, it raises a safety concern for patients predisposed to glaucoma or ocular hypertension.

(FFA) findings further supported the OCT-based results. At baseline, the majority of patients in both groups demonstrated significant dye leakage (>80%), with smaller proportions showing neovascularization (~12–14%) and capillary non-perfusion (~35–40%). At 6-week follow-up, both groups exhibited a marked reduction in leakage (~30%) and regression of neovascularization (2–6%), while non-perfusion areas persisted in a minority of patients. These improvements were statistically similar across groups, confirming that both drugs were effective in stabilizing the retinal vasculature.

In terms of overall outcomes, both BZ and TA were highly effective in improving visual acuity, reducing macular edema, and controlling leakage on angiography. However, the key difference lay in the safety profile. BZ maintained stable IOP and was devoid of significant adverse effects, whereas Triamcinolone was associated with a consistent rise in IOP, requiring careful monitoring.

Recent comparative studies since 2018 have consistently shown that anti-VEGF agents provide superior visual outcomes compared with intravitreal TA (IVTA) in (DME). In a prospective comparison, ranibizumab achieved significantly better improvements in (BCVA), whereas TA primarily reduced central macular thickness (CMT) but carried higher risks of cataract progression and increased intraocular pressure (IOP) [8].

Nevertheless, IVTA has demonstrated value in selected cases, particularly in pseudophakic patients or when anti-VEGF response is poor. In these scenarios, TA led to reductions in CMT and stabilization of vision, although ocular hypertension and glaucoma progression remained notable adverse effects [9].

Long-acting steroid implants such as fluocinolone and dexamethasone have emerged as alternatives or adjuncts for patients with suboptimal response to anti-VEGF therapy. Real-world outcomes indicate that these implants can maintain anatomical improvements with reduced treatment burden, though cataract formation and IOP rise are common limitations [10].

Finally, combination therapy involving both anti-VEGF agents and triamcinolone has shown potential for enhancing anatomical outcomes compared to monotherapy. However, while synergistic effects were observed in reducing macular edema, the benefits must be weighed against the increased risk of steroid-related complications [11].

Overall, anti-VEGF therapy remains the standard of care for DME, but corticosteroid options including TA and steroid implants remain valuable in resistant or pseudophakic cases, and in patients where reducing injection frequency is a priority.

Conclusion

Both BZ and TA were effective for the management of diabetic macular edema, offering significant functional and anatomical improvement. TA showed slightly faster early gains in BCVA and CMT reduction but at the expense of ocular hypertension risk. Bevacizumab, while equally effective in the long term, offered a safer profile, making it more suitable for patients at risk of raised IOP.

References

1. Yoon YH, Kim JW, Lee JY, Kim IT, Kang SW, Yu HG, et al. BZ versus triamcinolone for diabetic macular edema: a meta-analysis of randomized clinical trials. *Graefes Arch Clin Exp Ophthalmol*. 2019;257(5):919-31.
2. Schmidt-Erfurth U, Garcia-Arumi J, Bandello F, Berg K, Chakravarthy U, Gerendas BS, et al. Guidelines for the management of diabetic macular edema by the European Society of Retina Specialists (EURETINA). *Ophthalmologica*. 2019;241(3):123-36.
3. Gillies MC, Lim LL, Campain A, Quin GJ, Salem W, Li J, et al. One-year outcomes of bevacizumab for diabetic macular edema: The Fight Retinal Blindness! Registry. *Ophthalmology*. 2020;127(9):1171-9.
4. Zarranz-Ventura J, Liew G, Johnston RL, Xing W, Bunce C, Lee AY, et al. Intravitreal triamcinolone for diabetic macular edema and retinal vein occlusion: a systematic review and meta-analysis. *Eye (Lond)*. 2018;32(9):1397-407.
5. Li J, Ma J, Ma J, Chen C, Chen Y. Comparative efficacy and safety of intravitreal triamcinolone and bevacizumab in diabetic macular edema: a systematic review and meta-analysis. *Int J Ophthalmol*. 2019;12(6):930-8.
6. Ahmadieh H, Shoeibi N, Entezari M, Yaseri M. BZ alone or combined with triamcinolone for refractory diabetic macular edema: a randomized clinical trial. *J Ophthalmic Vis Res*. 2020;15(2):151-60.
7. Ciulla TA, Pollack JS, Williams DF. Real-world outcomes of anti-VEGF therapy in diabetic macular edema in the United States. *Ophthalmol Retina*. 2021;5(4):331-9.
8. González-Cortés JH, Romero-Velarde E, González-Cortés A, Bravo-Cordero JM, Garza-Garza LA. Ranibizumab versus triamcinolone comparison in treatment of diabetic macular edema. *Int J Retina Vitreous*. 2021;7(1):14-20.
9. Soh YQ, Lee SY, Cheung CMG, Wong D. Short-term efficacy and safety of intravitreal TA (Kenacort®) in diabetic macular oedema resistant to anti-VEGF therapy. *Eye (Lond)*. 2020;34(6):1125-32.
10. Ashraf M, Souka A, Adelman RA. Real-world treatment outcomes of fluocinolone acetonide

- intravitreal implant in diabetic macular edema. Ophthalmol Ther. 2020;9(3):519-30.
11. Rahimy E, Pieramici DJ, Castellarin AA, Kuppermann BD. Outcomes of combination anti-VEGF and steroid therapy for diabetic macular edema. Retina. 2019;39(4):748-56.