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Visual and Anatomical Outcomes of Intravitreal Bevacizumab for Diabetic Macular Edema at Preah Ang Duong Hospital

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Abstract: ***Purpose**: This study was conducted to evaluate the visual outcomes of intravitreal Bevacizumab in patients with diabetic macular edema (DME) treated at Preah Ang Duong Hospital. The primary outcome measure was improvement in best-corrected visual acuity (BCVA), while secondary outcomes included reduction in central macular thickness (CMT), intraocular pressure (IOP) changes, treatment safety, and sustainability of visual improvement during follow-up. **Methods**: This was a prospective hospital-based study involving 97 patients with diabetic macular edema who received monthly intravitreal Bevacizumab injections at Preah Ang Duong Hospital, Phnom Penh, Cambodia. Baseline and follow-up assessments included socio-demographic characteristics, systemic comorbidities, BCVA, CMT measured by optical coherence tomography, IOP, and adverse events. Data were entered using EpiData and imported into SPSS version 25 for statistical analysis. Descriptive statistics were presented as mean, standard deviation, frequency, and percentage. Baseline and follow-up outcomes were compared using paired t-test and repeated-measures ANOVA, with a p-value < 0.05 considered statistically significant. **Results**: The mean age of patients was 58.4 ± 9.3 years, ranging from 34 to 79 years, and 52 patients (53.6%) were male. Most participants had type 2 diabetes mellitus (90.7%), and the most common systemic comorbidity was hypertension (49.5%). Mean baseline BCVA was 0.68 ± 0.32 logMAR and improved to 0.42 ± 0.28 logMAR after treatment, with a mean improvement of 0.26 logMAR (p < 0.001). Mean baseline CMT decreased from 455 ± 98 µm to 312 ± 74 µm, with a mean reduction of 143 µm (p < 0.001). Mean IOP changed from 15.1 ± 3.1 mmHg to 15.8 ± 3.4 mmHg, with no statistically significant increase (p = 0.18). Visual improvement was maintained throughout the follow-up period. Adverse events were observed in 8.2% of patients and were limited to minor complications, including subconjunctival hemorrhage, mild ocular pain, and transient IOP rise. No serious complications were recorded. **Conclusion**: Intravitreal Bevacizumab significantly improved visual acuity and reduced central macular thickness in patients with diabetic macular edema over the study period, with no serious safety concerns observed. These findings support its practical use in resource-limited clinical settings.*

Keywords: Diabetic Macular Edema; Bevacizumab; Intravitreal Anti-VEGF; Optical Coherence Tomography; Visual Acuity; Cambodia

1. Introduction

Diabetic macular edema (DME) is one of the most common and vision-threatening complications of diabetic retinopathy. It develops due to breakdown of the blood-retinal barrier, resulting in increased vascular permeability and fluid accumulation in the macula. Since the macula is responsible for central detailed vision, this condition can lead to blurred vision, distortion, and significant impairment in daily activities. DME remains a major cause of visual loss among working-age adults worldwide [1] [2].

The burden of diabetes mellitus continues to rise globally, particularly in low- and middle-income countries, and the prevalence of diabetic retinopathy and DME is increasing accordingly [3]. In Cambodia, diabetic eye disease is being encountered more frequently in ophthalmic practice. However, despite the importance of this problem, there are still limited local data on treatment outcomes in Cambodian patients.

Several treatment modalities have been used in the management of DME, including laser photocoagulation, intravitreal corticosteroids, and anti-vascular endothelial growth factor (anti-VEGF) therapy [4] [5]. In recent years, anti-VEGF agents have become the standard treatment for center-involving DME because they directly target the underlying pathophysiology of increased vascular permeability [5,11]. Among these agents, Bevacizumab is widely used because of its lower cost compared with ranibizumab and aflibercept, making it particularly relevant in resource-limited settings [7].

Previous studies have demonstrated that intravitreal Bevacizumab can improve best-corrected visual acuity and reduce central macular thickness in patients with DME [7,10]. Nevertheless, evidence from Cambodia remains limited. Therefore, this prospective study was conducted at Preah Ang Duong Hospital to evaluate the visual outcomes of intravitreal Bevacizumab in patients with diabetic macular edema and to provide local evidence to support clinical practice.

2. Methods

This was a hospital-based prospective study involving patients with diabetic macular edema who received intravitreal Bevacizumab at Preah Ang Duong Hospital, Phnom Penh, Cambodia, from February 2025 to March 2026. A convenience sampling method was used, and all eligible patients who met the inclusion criteria and agreed to participate during the study period were included. Ethical approval was obtained from the National Ethics Committee for Health Research on 16 January 2025, and administrative approval was obtained from Preah Ang Duong Hospital.

Written informed consent was obtained from each patient before treatment.

Patients were included if they had clinically and OCT-confirmed diabetic macular edema, were aged 18 years or older, had no previous treatment for DME, were considered suitable for intravitreal Bevacizumab, and agreed to attend follow-up visits. Patients were excluded if they had advanced cataract affecting visual acuity assessment, vitreous hemorrhage, previous intravitreal injection or laser treatment for DME, coexisting retinal diseases, history of intraocular surgery within the previous 3 months, or severe systemic illness preventing follow-up.

For patients with bilateral diabetic macular edema, only one study eye was included in the analysis to avoid inter-eye correlation. The study eye was selected based on clinical indication for treatment and availability of complete baseline and follow-up data. Therefore, the statistical analysis was performed at the patient-eye level, with one eye representing one patient.

Patient demographic information, diabetic history, duration of diabetes, systemic comorbidities, and relevant ophthalmic history were recorded. All participants underwent baseline ocular examination including best-corrected visual acuity (BCVA), optical coherence tomography for central macular thickness (CMT), and intraocular pressure (IOP) measurement. BCVA was measured using a Snellen visual acuity chart and converted to logMAR values for statistical analysis.

2.1 Injection Procedure and Treatment Protocol

Intravitreal Bevacizumab injection was performed under strict aseptic conditions. Bevacizumab was administered at a dose of 1.25 mg/0.05 mL. Standard preparation included topical anesthesia, antisepsis with povidone-iodine, and sterile technique throughout the procedure.

Patients received monthly intravitreal Bevacizumab injections for three consecutive months. Follow-up assessments were performed at Month 1, Month 2, and Month 3 to evaluate treatment response and monitor safety. At each follow-up visit, best-corrected visual acuity (BCVA), central macular thickness (CMT) by optical coherence tomography, intraocular pressure (IOP), and adverse events were assessed.

2.2 Follow-Up Evaluation

Patients were evaluated monthly during the three-month treatment period. Follow-up examinations included BCVA measurement, OCT assessment of CMT, IOP measurement, and documentation of ocular or systemic adverse events. The sustainability of visual improvement was assessed by comparing BCVA changes from baseline to Month 1, Month 2, and Month 3.

2.3 Data Entry and Analysis

Data entry was performed using EpiData and then imported into Statistical Package for Social Sciences (SPSS) software version 25 for analysis. Continuous variables were summarized as mean ± standard deviation, while categorical variables were summarized as frequency and percentage. The paired t-test was used to compare baseline and final BCVA, CMT, and IOP. Repeated-measures analysis of variance (repeated-measures ANOVA) was used to assess changes in BCVA across baseline, Month 1, Month 2, and Month 3. Patients with incomplete follow-up data were excluded from repeated-measures analysis, and complete-case analysis was performed. A p-value < 0.05 was considered statistically significant.

3. Results

A total of 97 patients with diabetic macular edema were included in the study. The socio-demographic and clinical baseline characteristics are summarized in Table 1.

The mean age of participants was 58.4 ± 9.3 years (range: 34 - 79 years). Patients aged 60 years or older accounted for 56 (57.7%), while 41 (42.3%) were younger than 60 years. There were 52 males (53.6%) and 45 females (46.4%). Most participants resided in Phnom Penh or urban areas (63, 64.9%), while 34 (35.1%) came from provincial or rural areas. Most patients had type 2 diabetes mellitus (88, 90.7%), whereas 9 (9.3%) had type 1 diabetes mellitus. The mean duration of diabetes was 11.6 ± 6.7 years (range: 1 - 30 years). The most common systemic comorbidity was hypertension (48, 49.5%), followed by dyslipidemia (37, 38.1%), ischemic heart disease (11, 11.3%), and chronic kidney disease (9, 9.3%). Baseline ophthalmic characteristics showed a mean BCVA of 0.68 ± 0.32 logMAR (range: 0.3 - 1.3), mean CMT of 455 ± 98 µm (range: 320 - 720 µm), and mean IOP of 15.1 ± 3.1 mmHg (range: 9 - 24 mmHg). No patient had received prior DME therapy according to the inclusion criteria.

Table 1: Socio- Demographic and Clinical Baseline of participants (n=97)

Characteristics	Frequency (%) or mean ± SD (range)
Age	58.4 ± 9.3 (34–79)
< 60 years	41 (42.3%)
≥ 60 years	56 (57.7%)
Sex	
Male	52 (53.6%)
Female	45 (46.4%)
Residence	
Phnom Penh / Urban	63 (64.9%)
Provincial / Rural	34 (35.1%)
Diabetes profile	
Type 1 diabetes	9 (9.3%)
Type 2 diabetes	88 (90.7%)
Diabetes duration (years)	11.6 ± 6.7 (1–30)
Ophthalmic baseline	
BCVA (logMAR), study eye	0.68 ± 0.32 (0.3–1.3)
CMT (µm), study eye	455 ± 98 (320–720)
IOP (mmHg), study eye	15.1 ± 3.1 (9–24)
Prior DME therapy	None (per inclusion criteria)
Comorbidities	
Hypertension	48 (49.5%)
Dyslipidemia	37 (38.1%)
Ischemic heart disease	11 (11.3%)
Chronic kidney disease	9 (9.3%)

Abbreviations:
BCVA = Best-Corrected Visual Acuity;

CMT = Central Macular Thickness;
IOP = Intraocular Pressure;
DME = Diabetic Macular Edema.

3.1 Visual Outcome

The mean baseline BCVA was 0.68 ± 0.32 logMAR. After treatment, the mean final BCVA improved to 0.42 ± 0.28 logMAR, representing a mean improvement of 0.26 logMAR. This difference was statistically significant ($p < 0.001$). The comparison between baseline and final BCVA is shown in Figure 1.

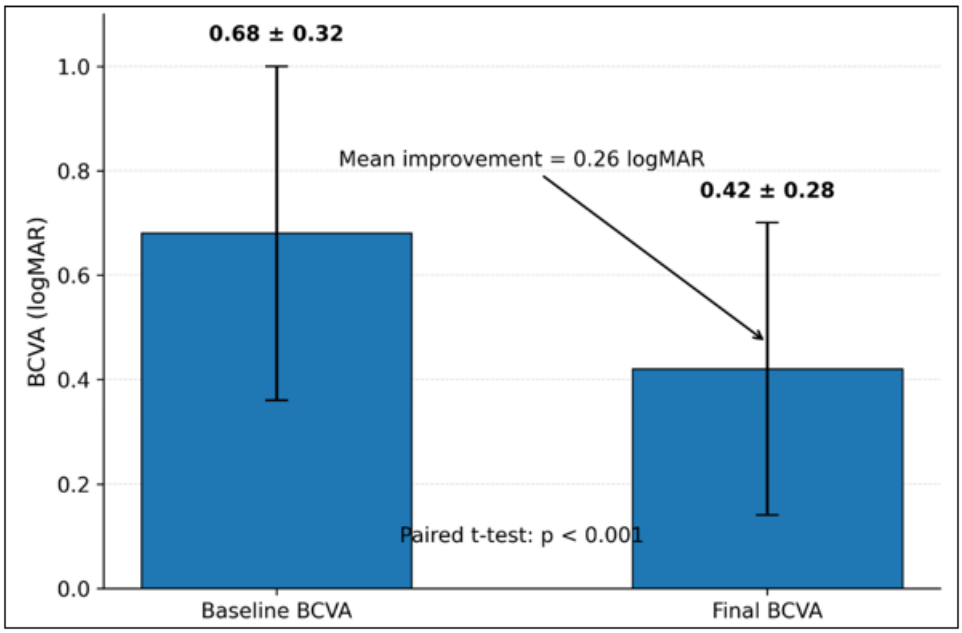

Figure 1: Comparison between baseline and final best- corrected visual activity

3.2 Anatomical Outcome

The mean baseline central macular thickness was 455 ± 98 µm, which decreased to 312 ± 74 µm after treatment. This represented a mean reduction of 143 µm, and the difference was statistically significant ($p < 0.001$). The comparison between baseline and final CMT is shown in Figure 2.

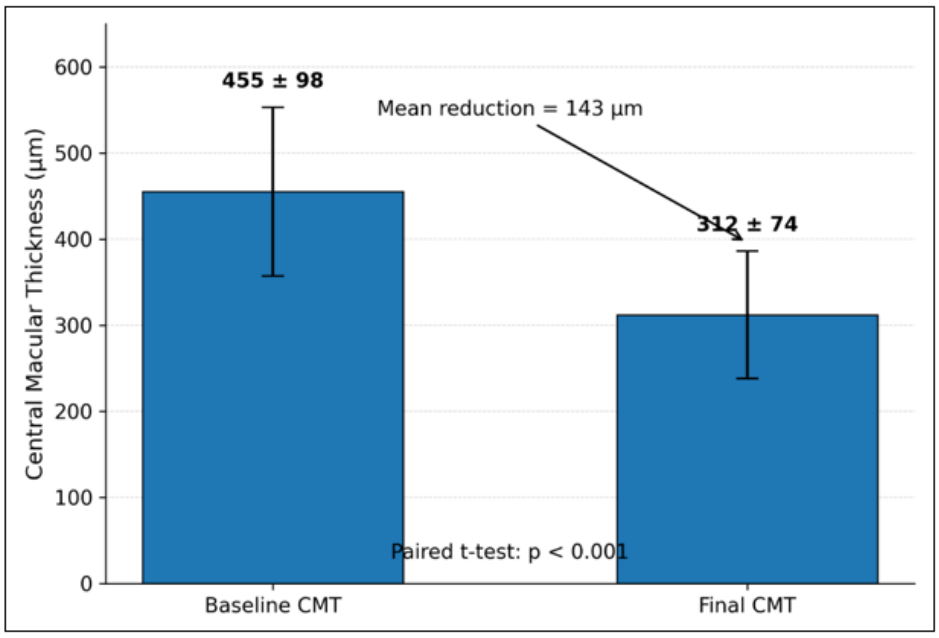

Figure 2: Comparison between baseline and final central macular thickness

3.3 Intraocular Pressure Outcome

The mean IOP changed from 15.1 ± 3.1 mmHg at baseline to 15.8 ± 3.4 mmHg at follow-up, corresponding to a mean increase of 0.7 mmHg. However, this increase was not statistically significant ($p = 0.18$). The main treatment outcomes after intravitreal Bevacizumab are summarized in Table 2.

Table 2: Treatment Outcomes after intravitreal Bevacizumab injection

Outcome	Baseline	Final follow-up	Mean change	p-value
BCVA, logMAR	0.68 ± 0.32	0.42 ± 0.28	0.26 improvement	<0.001
CMT, µm	455 ± 98	312 ± 74	143 reduction	<0.001
IOP, mmHg	15.1 ± 3.1	15.8 ± 3.4	0.7 increase	0.18

Abbreviations:
BCVA = Best-Corrected Visual Acuity;
CMT = Central Macular Thickness;
IOP = Intraocular Pressure;
Values are presented as mean + Standard Deviation. P Values were calculated using paired t- test

3.4 Duration of Efficacy and Sustainability of Visual Improvement

Visual acuity improved progressively over time and remained better than baseline throughout follow-up. Mean BCVA changed from 0.68 ± 0.32 logMAR at baseline to 0.55 ± 0.30 at Month 1, 0.47 ± 0.29 at Month 2, and 0.42 ± 0.28 at Month 3. Repeated measures analysis showed that this improvement over time was statistically significant ($p < 0.001$). The duration of efficacy and sustainability of visual improvement is presented in Figure 3.

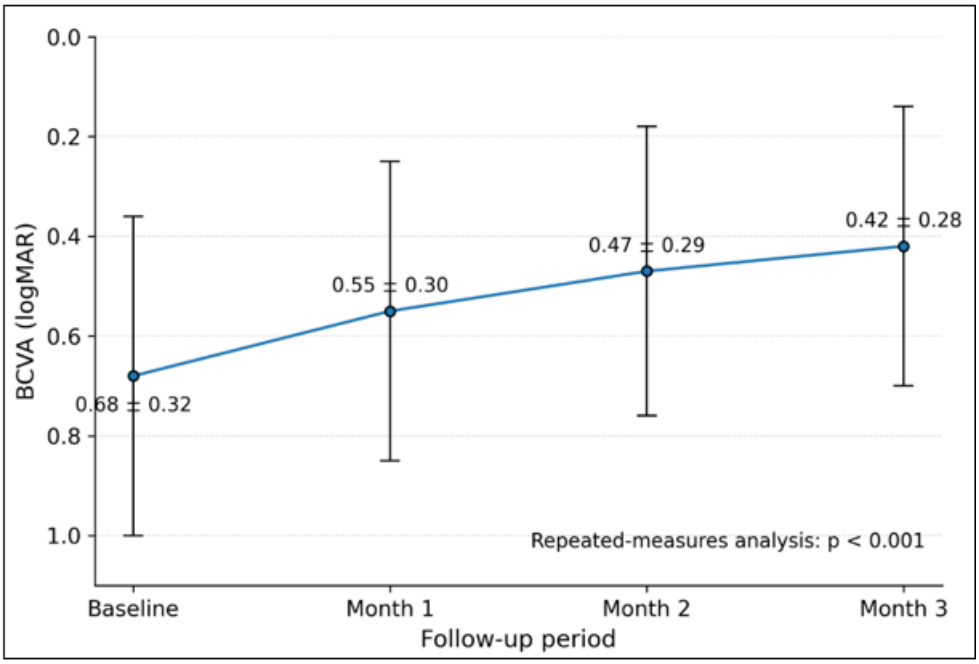

Figure 3: Duration of Efficacy and Sustainability of Visual Acuity improvement

3.5 Safety Profile

Adverse events were observed in 8 patients (8.2%) and were limited to minor complications. These included subconjunctival hemorrhage in 4 cases, mild ocular pain in 3 cases, and transient IOP rise in 1 case. No serious complications were recorded. The safety profile is shown in Figure 4.

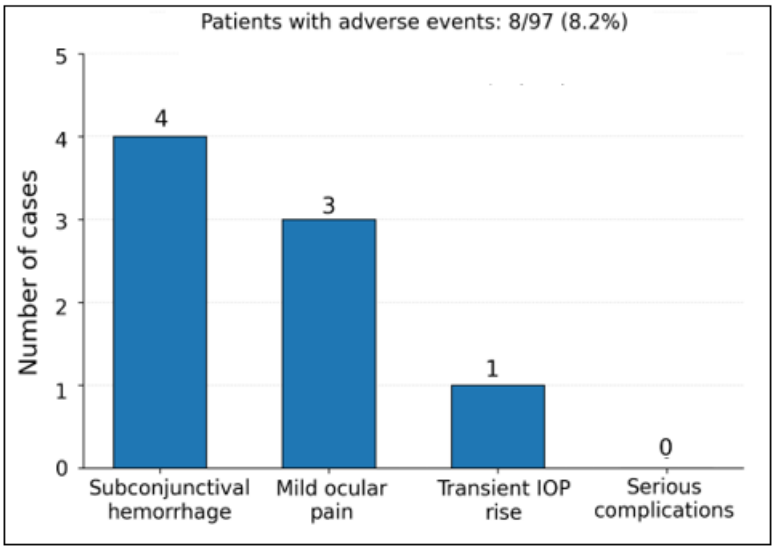

Figure 4: Safety Profile: Adverse Events after Intravitreal Bevacizumab Injection

3.6 Follow-Up Compliance

Follow-up compliance was satisfactory overall. Eighty-nine patients (91.8%) completed all scheduled visits, while 8 patients (8.2%) missed at least one follow-up visit. The main reasons included personal constraints, transportation difficulties, and systemic illness.

4. Discussion

In this prospective hospital-based study, intravitreal Bevacizumab was associated with significant improvement in best-corrected visual acuity and significant reduction in central macular thickness among patients with diabetic macular edema treated at Preah Ang Duong Hospital. Mean BCVA improved from 0.68 ± 0.32 logMAR at baseline to 0.42 ± 0.28 logMAR after treatment, while mean CMT decreased from 455 ± 98 µm to 312 ± 74 µm. These findings indicate that Bevacizumab provided both functional and anatomical benefits in this study population.

The visual and anatomical improvements observed in our study are consistent with previous Bevacizumab-specific evidence. Wells et al. demonstrated meaningful improvement in visual acuity among patients treated with anti-VEGF agents, including Bevacizumab, for DME [7]. Similarly, the BOLT study reported favorable outcomes with intravitreal Bevacizumab compared with laser therapy in patients with DME [10]. Our finding of a significant BCVA improvement therefore supports the established role of Bevacizumab as an effective treatment option.

The reduction in central macular thickness observed in our study is also in agreement with previous evidence that Bevacizumab can reduce retinal edema by decreasing vascular permeability. The significant decrease in CMT from baseline to follow-up suggests that treatment effectively controlled the anatomical component of DME. This anatomical response is important because persistent edema is associated with continued visual dysfunction and worse prognosis.

Although our results are generally consistent with the literature, the magnitude of BCVA and CMT change may differ from other studies. Several factors may explain such differences. First, baseline disease severity can vary between studies. Patients with worse initial BCVA or thicker maculae may show greater absolute improvement, while those with milder disease may show more limited measurable change. Second, differences in follow-up duration can influence the apparent treatment effect, as some studies report short-term outcomes while others assess longer-term responses. Third, treatment protocols may differ, including number of injections, retreatment criteria, and monitoring schedules. In addition, real-world clinical practice settings, such as ours, often differ from controlled randomized trials in terms of patient adherence, systemic disease control, and access to repeated treatment. These factors may contribute to variation in observed outcomes.

An important finding in this study was that visual improvement was maintained during follow-up. BCVA improved progressively from baseline through subsequent visits and remained better than baseline throughout the observed follow-up period. This suggests that the benefit of intravitreal Bevacizumab was not only immediate but also sustained over time. In a chronic condition such as DME, durability of treatment effect is clinically meaningful because continued control of edema and preservation of vision are important goals of management.

The safety and practical relevance of Bevacizumab are particularly important in the Cambodian setting. No serious complications, such as endophthalmitis, retinal detachment, severe intraocular inflammation, or sustained IOP elevation, were observed in this study. Minor adverse events were limited to subconjunctival hemorrhage, mild ocular pain, and transient IOP rise. In resource-limited clinical settings, treatment decisions are strongly influenced by both safety and affordability. Compared with other anti-VEGF agents such as ranibizumab and aflibercept, Bevacizumab is more affordable and more accessible, which may improve treatment uptake and continuity among patients requiring repeated monitoring and injections. Therefore, these findings support the practical use of intravitreal Bevacizumab as an effective and feasible treatment option for DME in routine retinal services in Cambodia.

This study has several limitations. First, it was conducted at a single tertiary center, which may limit the generalizability of the findings to other settings. Second, the study did not include a control group or comparison with other anti-VEGF agents, which limits the ability to directly compare effectiveness across treatments. Third, although follow-up compliance was generally good, a small proportion of patients missed at least one scheduled visit, which may have influenced some outcome measurements. In addition, the follow-up period was relatively limited, and longer-term outcomes were not assessed. Despite these limitations, the study provides valuable prospective real-world data from a Cambodian tertiary hospital and contributes important local evidence to the literature.

Overall, the study supports intravitreal Bevacizumab as an effective, safe, and practical treatment option for diabetic macular edema in the Cambodian setting. The significant improvement in BCVA, significant reduction in CMT, sustained visual benefit during follow-up, and absence of serious complications strengthen the case for its continued use in routine clinical practice.

5. Conclusion

Intravitreal Bevacizumab was associated with significant improvement in visual acuity and reduction in central macular thickness in this cohort of patients with diabetic macular edema, with no serious complications observed during follow-up. It appears to be a practical treatment option in this clinical setting.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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