E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/16.02.575

Research Article

Clinical Profile, Risk Factors, and Visual Outcomes Following Intravitreal Ranibizumab Therapy in Patients with Diabetic Retinopathy

Muhammad Aamir Shahzad[1], Ghulam Abbas[2*], Muhammad Sohail Arshad[3], Asim Mehmood[4], Muhammad Awais Ashraf[5], Muhammad Shoaib Akram[6]

[1]Associate Professor, Ophthalmology Department, Aziz Fatimah Medical and Dental College, Faisalabad.

[2*]Associate Professor, Ophthalmology department, Multan Medical and Dental College, Multan.

[3]Associate Professor, Ophthalmology Department, Shahida Islam Medical and Dental College, Lodhran.

[4]Associate professor, Department of Ophthalmology, Multan Medical and Dental College, Multan.

[5]Assistant Professor, Department of Ophthalmology, Multan Medical and Dental College, Multan.

[6]Assistant Professor, Ophthalmology Department, Aziz Fatimah Medical and Dental College, Faisalabad.

Email ID: [1]aamshah72@hotmail.com, [2]drahanjum@yahoo.com, [3]sohailarshad84@gmail.com, [4]drasimeye2@hotmail.com, [5]awaisdr931@gmail.com, [6]Shouaibakram@gmail.com

Corresponding Author: Ghulam Abbas
Associate Professor, Ophthalmology department, Multan Medical and Dental College, Multan.
Email: drahanjum@yahoo.com

Received: 22.07.26, Revised: 28.08.26, Accepted: 22.09.26

ABSTRACT

Background: Diabetic retinopathy causes substantial avoidable visual impairment, while cost and irregular follow-up may limit intravitreal therapy in low-resource settings.

Objective: To describe the clinical profile, risk factors, and six-month visual outcomes following intravitreal ranibizumab among patients with diabetic retinopathy in Pakistan.

Methods: This prospective multicenter cohort included adults with centre-involving diabetic macular edema treated at three tertiary hospitals from January to December 2025. Participants received ranibizumab 0.5 mg as three monthly loading doses followed by pro re nata treatment. Best-corrected visual acuity, central subfield thickness, systemic risks, adherence, and adverse events were recorded. The primary outcome was a gain of at least 10 Early Treatment Diabetic Retinopathy Study letters at six months.

Results: Among 216 enrolled participants, 198 completed follow-up. Mean age was 57.6±8.9 years, 55.6% were men, and mean glycated hemoglobin was 8.6±1.4%. Visual acuity improved from 0.68±0.26 to 0.42±0.25 logMAR, while central subfield thickness decreased from 442±91 to 315±72 µm (both $p<0.001$). Eighty-six participants (43.4%) gained at least 10 letters. Adherence independently increased improvement, whereas glycated hemoglobin ≥9%, symptoms exceeding six months, and outer-retinal disruption reduced it. No endophthalmitis occurred.

Conclusion: Ranibizumab produced meaningful anatomical and visual improvement under routine tertiary-care conditions. Timely presentation, metabolic control, and scheduled injections were important response determinants.

Keywords: Diabetic Retinopathy, Diabetic Macular Oedema, Ranibizumab, Optical Coherence Tomography.

INTRODUCTION

Diabetic retinopathy (DR) remains one of the most frequent microvascular complications of diabetes and an important cause of preventable visual loss among working-age adults worldwide.[1] Global estimates indicate that the number of adults living with DR will continue to rise as diabetes becomes more prevalent and survival with the disease improves.[2] The burden is disproportionately important in low- and middle-income countries, where delayed diagnosis, limited retinal services, and out-of-pocket expenditure restrict access to timely care.[3] South Asian populations carry a rapidly expanding diabetes burden, making retinal screening and treatment an increasingly urgent public-health priority.[4]

Visual loss in DR commonly results from diabetic macular edema (DME), vitreous

hemorrhage, tractional retinal detachment, or macular ischemia.[5] Centre-involving DME is characterized by breakdown of the blood–retinal barrier, vascular leakage, and retinal thickening involving the fovea.[6] Chronic hyperglycemia, longer diabetes duration, hypertension, dyslipidaemia, renal dysfunction, and advanced retinopathy increase the probability of DME and disease progression.[7] Optical coherence tomography (OCT) permits reproducible measurement of central retinal thickness and identification of structural biomarkers associated with treatment response.[8]

Vascular endothelial growth factor has a central role in retinal vascular permeability and pathological neovascularisation, providing the biological basis for intravitreal anti-vascular endothelial growth factor therapy.[9] Ranibizumab is an antibody fragment that binds vascular endothelial growth factor A and has established efficacy for visual impairment caused by DME and for regression of DR severity.[10] Contemporary clinical guidance recommends anti-vascular endothelial growth factor treatment as first-line therapy for most eyes with vision-impairing centre-involving DME.[11] Nevertheless, outcomes achieved in clinical practice are often less favourable than those reported in controlled trials because patients receive fewer injections and have more variable follow-up.[12]

Pakistan faces a dual challenge of rapidly increasing diabetes prevalence and uneven access to specialist retinal care, particularly outside major metropolitan centers. Patients may first seek care after vision has deteriorated, when chronic edema, hard exudation, macular ischemia, or photoreceptor damage has already reduced the potential for recovery. The treatment burden is especially relevant in resource-constrained settings, where travel costs, medicine affordability, missed work, and limited appointment capacity may interrupt a loading schedule.[13] Ranibizumab biosimilars may improve affordability, but safe procurement, cold-chain maintenance, sterile administration, and structured monitoring remain essential.[14] Evidence describing both clinical response and modifiable determinants of response in Punjab is limited. The present study therefore evaluated the clinical profile, systemic and ocular risk factors, treatment adherence, anatomical response, and six-month visual outcomes following intravitreal ranibizumab among patients with DR treated at three tertiary hospitals in Punjab.

MATERIALS AND METHODS

A prospective multicenter cohort study was conducted at the ophthalmology departments of three tertiary-care hospitals in Punjab, Pakistan, from January to December 2025. Consecutive patients were enrolled from January through June and followed for six months, allowing completion of follow-up within the study period. Ethical approval was obtained from the institutional review boards of all participating hospitals. Written informed consent was obtained from every participant, and the study was conducted in accordance with the Declaration of Helsinki.

Adults aged 18 years or older with type 1 or type 2 diabetes, DR, OCT-confirmed center-involving DME, and best-corrected visual acuity (BCVA) between 20/40 and 20/400 in the study eye were eligible. Centre involvement was defined as retinal thickening affecting the central 1-mm subfield, with central subfield thickness (CST) of at least 300 µm on spectral-domain OCT. Treatment-naïve eyes and eyes without anti-vascular endothelial growth factor therapy during the preceding six months were included. Eyes with active ocular infection, uncontrolled glaucoma, visually significant cataract preventing reliable assessment, macular edema from another cause, vitreomacular traction requiring surgery, advanced macular ischemia, recent intraocular surgery, or previous vitrectomy were excluded. Patients with recent myocardial infarction, stroke, pregnancy, or known hypersensitivity to ranibizumab were also excluded. When both eyes were eligible, the eye with poorer BCVA was selected; if acuity was equal, one eye was selected by computer-generated randomization.

The required sample was calculated for a 40% anticipated proportion gaining at least 10 letters, 95% confidence, 7% absolute precision, and 10% possible loss to follow-up, yielding a minimum of 207 participants. A target of 216 was used to permit balanced recruitment across the three sites. A shared case-record form, investigator briefing, uniform Snellen-to-logMAR conversion chart, and identical outcome definitions were used across the sites. The principal study variables and their operational definitions are presented in **Table 1.**

Table 1. Study Variables and Operational Definitions

Domain	Variable	Operational definition or measurement
Primary outcome	Clinically meaningful visual gain	Increase of ≥10 ETDRS-equivalent letters, corresponding to a reduction of ≥0.20 logMAR, from baseline to month 6
Visual function	BCVA	Refraction-based Snellen visual acuity converted to logMAR; change was also expressed as approximate ETDRS letters
Anatomical response	CST	Central 1-mm subfield thickness on spectral-domain OCT; anatomical response was defined as a reduction of ≥20%
Treatment exposure	Ranibizumab adherence	Receipt of all three loading injections and attendance within ±14 days of scheduled visits
Systemic factors	Glycemic and vascular status	HbA1c, blood pressure, diabetes duration, dyslipidaemia, nephropathy, and smoking
Ocular factors	DR and OCT profile	NPDR or PDR, prior laser, lens status, intraretinal or subretinal fluid, hard exudates, DRIL, and ellipsoid-zone disruption

At baseline, trained research officers recorded age, sex, residence, education, smoking, diabetes type and duration, medication use, comorbid hypertension, dyslipidaemia, nephropathy, and previous retinal treatment. Blood pressure, glycated hemoglobin (HbA1c), and serum creatinine were recorded using routine hospital testing. A retina specialist performed slit-lamp biomicroscopy, intraocular-pressure measurement, dilated fundus examination, and DR grading using the International Clinical Diabetic Retinopathy Disease Severity Scale.

BCVA was measured after refraction using a Snellen chart at six meters and converted to logarithm of the minimum angle of resolution (logMAR). Spectral-domain OCT recorded CST, intraretinal fluid, subretinal fluid, disorganization of retinal inner layers (DRIL), and ellipsoid-zone integrity. Fundus fluorescein angiography was reserved for suspected macular ischemia or unexplained poor vision to limit cost and exposure.

Ranibizumab 0.5 mg/0.05 mL was administered under sterile operating-room or designated intravitreal-procedure-room conditions. After topical anesthesia and 5% povidone–iodine preparation, the injection was delivered through the pars plana with a sterile 30-gauge needle. Patients received three monthly loading injections, followed by monthly evaluation and pro re nata reinjection when OCT showed persistent or recurrent center-involving fluid, CST increased by at least 50 µm, or BCVA declined by at least five letters with evidence of DME activity.

Focal or grid laser was permitted after month three for persistent non-center-threatening leakage at the treating specialist's discretion. Panretinal photocoagulation was provided for proliferative disease when clinically indicated. Follow-up assessments at months 1, 2, 3, and 6 included BCVA, intraocular pressure, slit-lamp examination, dilated fundus assessment, OCT, treatment delivery, and adverse-event surveillance.

Data were analyzed using SPSS version 26.0. Baseline and six-month outcomes were compared using appropriate paired tests. Predictors of a ≥10-letter gain were evaluated using multivariable logistic regression and reported as adjusted odds ratios with 95% confidence intervals. A p-value <0.05 was considered statistically significant.

RESULTS

Of 247 patients assessed, 216 met the eligibility criteria and received at least one ranibizumab injection. Eighteen participants did not complete the six-month assessment, leaving 198 (91.7%) in the outcome analysis. Nine were lost because of travel or relocation, six discontinued because of treatment cost, and three could not be contacted. Completers and non-completers did not differ significantly in baseline age, sex, BCVA, CST, or HbA1c. Recruitment was balanced across the three participating hospitals, and no center contributed more than one-third of the analyzed cohort.

The cohort was predominantly middle-aged or older and had longstanding, sub optimally controlled diabetes. Hypertension and dyslipidaemia were common, and approximately one-quarter had documented diabetic nephropathy. The demographic and systemic characteristics are presented in **Table 2**. These findings indicate that the treated population carried several vascular risk factors in addition to ocular disease.

Table 2. Baseline demographic and systemic profile of participants completing follow-up (n=198)

Characteristic	Value
Age, years	57.6±8.9
Male sex	110 (55.6%)
Urban residence	126 (63.6%)
Type 2 diabetes	188 (94.9%)
Duration of diabetes, years	11.8±6.1
HbA1c, %	8.6±1.4
HbA1c ≥9%	76 (38.4%)
Hypertension	121 (61.1%)
Dyslipidaemia	89 (44.9%)
Diabetic nephropathy	48 (24.2%)
Current smoker	28 (14.1%)
Symptom duration >6 months	83 (41.9%)

Severe non-proliferative DR was the most frequent retinopathy category, while nearly one-third of eyes had proliferative disease. Diffuse OCT thickening, intraretinal fluid, and hard exudates were frequent, while outer-retinal disruption was present in approximately one-third. Prior retinal laser treatment was recorded in 28.8% of eyes. Baseline ocular and imaging findings are summarized in **Table 3**, indicating substantial disease severity at presentation.

Table 3. Baseline Ocular and Optical Coherence Tomography Characteristics (N=198 Eyes)

Characteristic	Value
Baseline BCVA, logMAR	0.68±0.26
Baseline CST, µm	442±91
Moderate NPDR	38 (19.2%)
Severe NPDR	99 (50.0%)
Proliferative DR	61 (30.8%)
Intraretinal fluid	183 (92.4%)
Subretinal fluid	46 (23.2%)
Hard exudates involving central 3 mm	112 (56.6%)
DRIL	80 (40.4%)
Ellipsoid-zone disruption	67 (33.8%)
Prior focal/grid or panretinal laser	57 (28.8%)
Pseudophakia	49 (24.7%)

Participants received a mean of 4.1±1.0 injections during six months; 151 (76.3%) completed all three loading injections within the scheduled windows, and 137 (69.2%) attended every planned assessment within ±14 days. BCVA improved progressively, with the largest gain occurring during the loading phase and a smaller additional gain thereafter. CST fell in parallel, and the reduction was maintained at month six. **Table 4** demonstrates statistically and clinically meaningful improvement in both functional and anatomical measures.

Table 4. Change In Visual and Anatomical Outcomes During Follow-Up (N=198)

Outcome	Baseline	Month 3	Month 6	p-value*
BCVA, logMAR	0.68±0.26	0.49±0.25	0.42±0.25	<0.001
Approximate ETDRS letters	51.0±13.0	60.5±12.5	64.0±12.5	<0.001
CST, µm	442±91	337±78	315±72	<0.001
Intraocular pressure, mmHg	15.3±2.8	15.6±2.9	15.4±2.7	0.436

*Repeated-measures comparison across visits.

At six months, 86 participants (43.4%) achieved the primary outcome of a gain of at least 10 letters, including 39 (19.7%) who gained at least 15 letters. Vision remained within five letters of baseline in 83 participants (41.9%), while 29 (14.6%) lost at least five letters. An anatomical response of at least

20% CST reduction occurred in 139 eyes (70.2%). Outcome categories and treatment exposure are detailed in **Table 5.** The visual response was less frequent than the anatomical response, suggesting that chronic or structural macular damage limited functional recovery in some eyes despite reduced thickness.

Table 5. Six-Month Outcomes and Treatment Exposure (N=198)

Outcome	n (%) or mean±SD
Gain ≥10 letters, primary outcome	86 (43.4%)
Gain ≥15 letters	39 (19.7%)
Stable vision, change within ±5 letters	83 (41.9%)
Loss ≥5 letters	29 (14.6%)
CST reduction ≥20%	139 (70.2%)
Dry central subfield at month 6	91 (46.0%)
Number of ranibizumab injections	4.1±1.0
Completed three loading injections on schedule	151 (76.3%)
Received adjunctive retinal laser	31 (15.7%)

In univariable analysis, scheduled loading-dose completion, shorter symptom duration, lower HbA1c, absence of ellipsoid-zone disruption, poorer baseline BCVA, and greater baseline CST were associated with a ≥10-letter gain. After adjustment, completing the loading schedule remained the strongest positive determinant. Poor glycemic control, delayed presentation, and ellipsoid-zone disruption independently reduced the likelihood of meaningful visual improvement, while greater baseline CST was associated with higher odds of improvement. The final model had acceptable calibration, with a Hosmer–Lemeshow p-value of 0.62, and no problematic multicollinearity. The adjusted estimates are shown in **Table 6.**

Table 6. Multivariable Predictors of A ≥10-Letter Gain at Six Months (N=198)

Predictor	AOR	95% CI	p-value
Completed loading injections on schedule	2.84	1.42–5.68	0.003
HbA1c ≥9%	0.46	0.24–0.88	0.019
Symptoms >6 months	0.52	0.28–0.97	0.040
Ellipsoid-zone disruption	0.39	0.19–0.78	0.008
Baseline CST, per 50-µm increase	1.28	1.05–1.56	0.015
Hypertension	0.79	0.42–1.49	0.468
Prior retinal laser	0.83	0.41–1.68	0.605

Treatment was generally well tolerated. Transient subconjunctival hemorrhage occurred after 17 injections, representing 2.1% of 812 injections. Mild self-limiting anterior-chamber inflammation occurred after four injections (0.5%), and a temporary intraocular-pressure rise above 25 mmHg occurred after six injections (0.7%). No case of endophthalmitis, retinal detachment, sustained ocular hypertension, myocardial infarction, or stroke was recorded during follow-up.

DISCUSSION

This multicenter cohort showed that intravitreal ranibizumab was associated with meaningful visual and anatomical improvement in patients with center-involving DME treated under routine tertiary-care conditions in Punjab. The mean improvement of approximately 13 letters and CST reduction of 127 µm were clinically relevant, although fewer than half of participants achieved a gain of at least 10 letters.[15] The difference between the mean change and categorical response reflected heterogeneity in baseline vision, disease chronicity, macular structure, systemic control, and treatment exposure.

The direction of benefit agrees with the five-year extension of DRCR Retina Network Protocol T, which confirmed sustained improvement following initial anti-vascular endothelial growth factor therapy, although visual gains declined when treatment and observation became less intensive. Protocol V also demonstrated that management should be guided by baseline visual impairment rather than OCT thickening alone because eyes with center-involving DME and good visual acuity may initially be observed.[16] All eyes in the

present cohort had visual impairment; therefore, active treatment was clinically appropriate.

The injection frequency was lower than fixed monthly regimens used in pivotal trials but resembled real-world practice, where treatment burden and missed visits reduce treatment exposure.[17] Observational evidence has consistently associated fewer injections and longer monitoring gaps with poorer visual outcomes in DME. The independent association between scheduled loading-dose completion and visual gain supports careful counseling, appointment reminders, and early financial planning at treatment initiation.[18] Ranibizumab remains an evidence-based treatment option, and growing experience with rigorously evaluated biosimilars may improve access where medicine cost is a major barrier.[19]

Poor glycemic control reduced the probability of visual gain, reinforcing that ocular treatment cannot be separated from systemic diabetes care. Hyperglycemia sustains endothelial dysfunction, inflammation, and vascular leakage, which may limit the durability of anti-vascular endothelial growth factor response.[20] Coordinated referral to physicians or diabetes clinics is particularly important for patients with HbA1c ≥9%, hypertension, nephropathy, or dyslipidaemia.[20] Delayed presentation also predicted a poorer response, which may reflect irreversible photoreceptor and neural injury caused by prolonged edema.

Ellipsoid-zone disruption was a strong negative predictor of improvement, while greater baseline CST was associated with higher odds of letter gain after adjustment. OCT biomarker studies have demonstrated that outer-retinal integrity and DRIL provide functional information beyond retinal thickness alone.[21] A thick but structurally preserved macula may contain considerable reversible fluid, whereas a thinner, chronically damaged retina may have limited visual potential.[21] OCT should consequently be used both to determine reinjection requirements and to counsel patients realistically about their expected recovery.

The anatomical response exceeded the visual response, a pattern also reported in comparative anti-vascular endothelial growth factor trials and contemporary DME studies.[22] Newer agents may permit longer dosing intervals, although their availability and cost remain limiting in many low-resource settings.[23] The absence of endophthalmitis and serious systemic events was reassuring and supported the safety of standardized povidone–iodine preparation, sterile technique, and structured post-injection surveillance.[24]

The prospective design, common outcome definitions, multicenter recruitment, OCT-based monitoring, and high follow-up rate strengthened the study. Longer studies incorporating patient-reported financial burden, standardized ETDRS testing, and comparative cost-effectiveness are needed.

CONCLUSION

Intravitreal ranibizumab produced significant six-month improvement in visual acuity and central retinal thickness among patients with vision-impairing center-involving diabetic macular edema treated at three tertiary hospitals in Punjab. Completion of the loading schedule favored meaningful visual gain, whereas poor glycemic control, delayed presentation, and ellipsoid-zone disruption predicted a weaker response. Integrating timely retinal referral, OCT-guided monitoring, metabolic risk-factor control, adherence support, and safe, affordable drug access may improve outcomes in resource-constrained ophthalmology services.

REFERENCES

1. Teo ZL, Tham YC, Yu M, Chee ML, Rim TH, Cheung N, et al. Global prevalence of diabetic retinopathy and projection of burden through 2045: systematic review and meta-analysis. Ophthalmology. 2021;128(11):1580–1591.
2. Bourne RRA, Steinmetz JD, Saylan M, Mersha AM, Weldemariam AH, Wondmeneh TG, et al. Causes of blindness and vision impairment in 2020 and trends over 30 years. Lancet Glob Health. 2021;9(2):e144–e160.
3. Sabanayagam C, Banu R, Chee ML, Lee R, Wang YX, Tan G, et al. Incidence and progression of diabetic retinopathy: a systematic review. Lancet Diabetes Endocrinol. 2019;7(2):140–149.
4. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: International Diabetes Federation; 2021. p. 1–141.
5. Vujosevic S, Aldington SJ, Silva P, Hernández C, Scanlon P, Peto T, et al. Screening for diabetic retinopathy: new

perspectives and challenges. Lancet Diabetes Endocrinol. 2020;8(4):337–347.

6. Das A, McGuire PG, Rangasamy S. Diabetic macular edema: pathophysiology and novel therapeutic targets. Ophthalmology. 2022;129(4):S1–S16.
7. Ting DSW, Cheung GCM, Wong TY. Diabetic retinopathy: global prevalence, major risk factors, screening practices and public health challenges. Clin Exp Ophthalmol. 2021;49(3):260–277.
8. Panozzo G, Cicinelli MV, Augustin AJ, Battaglia Parodi M, Cunha-Vaz J, Guarnaccia G, et al. An optical coherence tomography-based grading of diabetic maculopathy. Eur J Ophthalmol. 2020;30(1):8–18.
9. Stitt AW, Curtis TM, Chen M, Medina RJ, McKay GJ, Jenkins A, et al. The progress in understanding and treatment of diabetic retinopathy. Prog Retin Eye Res. 2020;76:100804.
10. Chatziralli I. Ranibizumab for the treatment of diabetic retinopathy. Expert Opin Biol Ther. 2021;21(8):991–997.
11. Flaxel CJ, Adelman RA, Bailey ST, Fawzi A, Lim JI, Vemulakonda GA, et al. Diabetic retinopathy Preferred Practice Pattern. Ophthalmology. 2020;127(1):P66–P145.
12. Ciulla TA, Bracha P, Pollack J, Williams DF. Real-world outcomes of anti-vascular endothelial growth factor therapy in diabetic macular edema in the United States. Ophthalmol Retina. 2019;3(12):1091–1098.
13. Cicinelli MV, Rabiolo A, Zollet P, Capone L, Lattanzio R, Bandello F. Persistent or recurrent diabetic macular edema after anti-VEGF treatment: therapeutic strategies. Surv Ophthalmol. 2021;66(6):953–971.
14. Sharma A, Kumar N, Parachuri N, Bandello F, Kuppermann BD, Loewenstein A. Biosimilars for retinal diseases: an update. Am J Ophthalmol. 2021;224:36–42.
15. Glassman AR, Wells JA III, Josic K, Maguire MG, Antoszyk AN, Baker C, et al. Five-year outcomes after initial aflibercept, bevacizumab, or ranibizumab treatment for diabetic macular edema. Ophthalmology. 2020;127(9):1201–1210.
16. Baker CW, Glassman AR, Beaulieu WT, Antoszyk AN, Browning DJ, Chalam KV, et al. Effect of initial management with aflibercept vs laser photocoagulation vs observation on vision loss among patients with diabetic macular edema involving the center of the macula and good visual acuity. JAMA. 2019;321(19):1880–1894.
17. Egan C, Zhu H, Lee A, Sim D, Mitry D, Bailey C, et al. The United Kingdom Diabetic Retinopathy Electronic Medical Record Users Group, report 1: baseline characteristics and visual acuity outcomes in eyes treated for diabetic macular oedema. Br J Ophthalmol. 2019;103(1):75–80.
18. Ziemssen F, Wachtlin J, Kuehlewein L, Gamulescu MA, Bertelmann T, Feucht N, et al. Intravitreal ranibizumab therapy for diabetic macular edema in routine practice: two-year outcomes of the non-interventional OCEAN study. Graefes Arch Clin Exp Ophthalmol. 2020;258(8):1655–1666.
19. Sharma A, Kondo M, Iwahashi C, Parachuri N, Kumar N, Bandello F, et al. Approved biosimilar ranibizumab—a global update. Eye (Lond). 2023;37(2):200–202.
20. Wong TY, Sabanayagam C. Strategies to tackle the global burden of diabetic retinopathy: from epidemiology to artificial intelligence. Ophthalmologica. 2020;243(1):9–20.
21. Sun JK, Lin MM, Lammer J, Prager S, Sarangi R, Silva PS, et al. Disorganization of the retinal inner layers as a predictor of visual acuity in eyes with center-involved diabetic macular edema. JAMA Ophthalmol. 2019;137(5):521–528.
22. Bressler SB, Beaulieu WT, Glassman AR, Gross JG, Jampol LM, Melia M, et al. Persistent macular thickening following intravitreous aflibercept, bevacizumab, or ranibizumab for central-involved diabetic macular edema. JAMA Ophthalmol. 2019;137(3):278–284.
23. Wykoff CC, Abreu F, Adamis AP, Basu K, Eichenbaum DA, Haskova Z, et al. Efficacy, durability, and safety of intravitreal faricimab with extended dosing in diabetic macular oedema: YOSEMITE and RHINE trials. Lancet. 2022;399(10326):741–755.
24. Kiss S, Dugel PU, Khanani AM, Broder MS, Chang E, Sun GH, et al. Endophthalmitis rates among patients receiving intravitreal anti-VEGF injections: a United States claims analysis. Clin Ophthalmol. 2020;14:2709–2716.