



MODERN APPROACHES TO THE TREATMENT OF DIABETIC RETINOPATHY

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Abstract

Diabetic retinopathy (DR) remains one of the leading causes of preventable vision loss and blindness among working-age adults worldwide. This review highlights current concepts in the pathogenesis, classification, and, most importantly, modern evidence-based therapeutic strategies for managing diabetic retinopathy, including systemic risk factor control, laser photocoagulation, intravitreal anti-VEGF agents, corticosteroid therapy, and vitrectomy. The article also discusses emerging technologies such as sustained-release drug implants and gene therapy prospects. Emphasis is placed on the importance of timely screening, multidisciplinary collaboration, and patient education to improve outcomes and preserve vision.

Keywords: diabetic retinopathy, anti-VEGF therapy, laser photocoagulation, intravitreal corticosteroids, vitrectomy, vision preservation.

1. Introduction

Diabetic retinopathy (DR) is a progressive microvascular complication of diabetes mellitus (DM) that affects the retinal vasculature. It is estimated that more than one-third of patients with diabetes will develop some degree of DR during their lifetime. According to the World Health Organization, DR is among the leading causes of preventable blindness globally, especially in individuals aged 20–64 years. The increasing prevalence of diabetes worldwide underscores the growing burden of DR on public health systems.

DR typically progresses from mild non-proliferative stages to more advanced forms, such as proliferative diabetic retinopathy (PDR) and diabetic macular edema (DME). Timely detection and intervention are crucial to prevent irreversible vision loss.

2. Pathogenesis and Risk Factors



The development of DR is primarily driven by chronic hyperglycemia-induced damage to the retinal microvasculature, resulting in capillary basement membrane thickening, pericyte loss, microaneurysm formation, and increased vascular permeability. Hypoxia triggers the upregulation of vascular endothelial growth factor (VEGF), leading to neovascularization in PDR.

Key modifiable risk factors include:

Poor glycemic control (HbA1c >7%)

Hypertension

Dyslipidemia

Long duration of diabetes (>10 years)

Renal dysfunction

Smoking

The landmark DCCT/EDIC and UKPDS studies have demonstrated that tight glycemic and blood pressure control significantly reduce the risk of DR onset and progression.

3. Current Classification

DR is clinically categorized into:

Non-proliferative diabetic retinopathy (NPDR): mild, moderate, severe.

Proliferative diabetic retinopathy (PDR): characterized by neovascularization.

Diabetic macular edema (DME): can occur at any stage and is a leading cause of vision loss.

Accurate classification using fundus photography, optical coherence tomography (OCT), and fluorescein angiography helps guide management.

4. Modern Treatment Strategies

4.1 Systemic Risk Factor Management

The cornerstone of DR management is optimal systemic control:

Intensive glycemic control (target HbA1c ~7%).

Blood pressure management (<140/90 mmHg).

Lipid-lowering therapy (statins, fenofibrate).



Lifestyle interventions, including weight control, diet modification, and smoking cessation, further reduce risk.

4.2 Laser Photocoagulation

Panretinal laser photocoagulation (PRP) has been the gold standard for treating PDR for decades. PRP works by ablating ischemic retinal tissue to reduce VEGF production. Focal/grid laser is also used for focal DME.

Although effective, laser therapy can be associated with side effects such as peripheral visual field loss and night vision impairment. The role of laser has shifted due to the advent of anti-VEGF therapy but remains vital in certain scenarios.

4.3 Anti-VEGF Therapy

Anti-VEGF agents have revolutionized the management of DME and, in some cases, PDR. They inhibit VEGF-mediated vascular leakage and neovascularization.

Key anti-VEGF agents:

Ranibizumab (Lucentis®)

Bevacizumab (Avastin®)

Aflibercept (Eylea®)

Major trials (e.g., DRCR.net Protocol T) have shown that aflibercept is superior in eyes with worse baseline vision, while bevacizumab remains a cost-effective alternative in resource-limited settings.

Challenges with anti-VEGF therapy include the need for repeated intravitreal injections, adherence issues, and logistical burden.

4.4 Intravitreal Corticosteroids

For patients who are non-responsive to anti-VEGF agents or cannot tolerate frequent injections, intravitreal corticosteroid implants (e.g., dexamethasone implant [Ozurdex®], fluocinolone acetonide implant [Iluvien®]) provide an alternative.

Steroids reduce inflammation and vascular permeability but are associated with risks such as cataract formation and elevated intraocular pressure (IOP), requiring close monitoring.

4.5 Vitrectomy

Pars plana vitrectomy (PPV) is indicated for advanced complications such as non-clearing vitreous hemorrhage, tractional retinal detachment, or severe fibrovascular proliferation unresponsive to medical therapy.



Modern small-gauge (23G, 25G, 27G) vitrectomy systems offer faster recovery and lower complication rates. Combined intraoperative anti-VEGF administration may improve surgical outcomes.

5. Emerging Therapies and Future Directions

Research is ongoing into sustained-release implants to reduce treatment burden, as well as gene therapies targeting VEGF pathways. Personalized medicine approaches, including biomarkers for predicting treatment response, hold promise for more effective individualized care.

Artificial intelligence (AI) is increasingly integrated into DR screening programs, improving early detection and facilitating timely referral.

6. The Role of Screening and Patient Education

Effective DR management depends on regular screening and early detection. Annual comprehensive dilated eye examinations are recommended for all diabetic patients, with more frequent monitoring for those at higher risk.

Educating patients about the importance of metabolic control, adherence to treatment, and recognizing early symptoms can significantly impact long-term visual outcomes.

7. Conclusion

Modern management of diabetic retinopathy has evolved into a multidisciplinary, individualized approach that combines systemic risk factor control with evidence-based local treatments such as anti-VEGF therapy, laser photocoagulation, and surgery when needed.

Continued research into new therapies, combined with accessible screening programs and patient-centered care, is essential to reduce the burden of vision impairment and improve quality of life for millions of people living with diabetes worldwide.



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