e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com doi: 10.25258/ijpqa.16.3.73

International Journal of Pharmaceutical Quality Assurance 2025; 16(3); 436-441

Original Research Article

Clinical and Biochemical Predictors of Retinopathy Severity in Individuals with Early-Onset Type 2 Diabetes Mellitus

Sudhanshu Kumar[1], Jawed Iqbal[2]

[1]Senior Resident, Department of Ophthalmology, Anugrah Narayan Magadh Medical College & Hospital, Gaya, Bihar, India

[2]Assistant Professor, Department of Ophthalmology, Anugrah Narayan Magadh Medical College & Hospital, Gaya, Bihar, India

Received: 10-01-2025 / Revised: 17-02-2025 / Accepted: 20-03-2025

Corresponding Author: Dr. Sudhanshu Kumar

Conflict of interest: Nil

Abstract:

Background: Diabetic retinopathy (DR) is a major microvascular complication of type 2 diabetes mellitus (T2DM), especially in individuals diagnosed at a younger age. Early identification of clinical and biochemical predictors is essential for timely intervention.

Aim: To evaluate the severity of diabetic retinopathy and its association with clinical and biochemical parameters in patients with early-onset T2DM.

Methods: A cross-sectional study was conducted on 94 patients with T2DM onset before 40 years of age. Data on demographics, clinical history, and biochemical markers were collected. Diabetic retinopathy was graded using standard fundoscopic criteria. Associations between clinical variables and DR severity were analyzed using chi-square tests, t-tests, and logistic regression.

Results: Among the participants, 33% had moderate NPDR, 20.2% had severe NPDR, and 19.1% had PDR. Duration of diabetes, HbA1c, nephropathy, and LDL levels were significantly associated with DR severity. Multivariate logistic regression identified nephropathy (OR: 4.71), HbA1c (OR: 1.58), LDL (OR: 1.34 per 10 mg/dL), and diabetes duration (OR: 1.22) as independent predictors of PDR.

Conclusion: The study demonstrates that poor glycemic control, nephropathy, elevated LDL, and longer diabetes duration are strong predictors of severe DR in early-onset T2DM. Early and aggressive metabolic management and routine ophthalmologic screening are vital to prevent vision-threatening complications.

Keywords: Diabetic retinopathy, Early-onset type 2 diabetes, LDL cholesterol, Microvascular complications, Nephropathy.

Introduction

Diabetic retinopathy (DR) is one of the most serious microvascular complications of diabetes mellitus and continues to be a major contributing factor to preventable blindness worldwide [1]. The global burden of diabetes is continuously growing, and failures in controlling diabetes effectively will have consequences for the care of people with diabetes complications, particularly in low- and middle-income countries [2]. The earlier individuals develop a diagnosis of type 2 diabetes mellitus (T2DM), typically defined as being diagnosed younger than 40 years of age, the more at risk they are of developing more aggressive and long-term complications as they will have been living with diabetes longer, and frequently have greater difficulties in managing glucose control. Despite many advancements in improving ocular health in people with diabetes, a large amount of recent literature focuses on retinopathy in type 1 diabetes and older-onset T2DM, therefore our understanding of the risk for individuals with early-onset T2DM has some critical gaps.

Early-onset T2DM is increasingly recognized as an independent clinical entity, characterized by a potentially faster rate of development of complications, increased prevalence of insulin resistance, and worse glycemic control compared to traditionally recognized late-onset T2DM [3]. The duration of hyperglycemia and the influence of metabolic derangements from the prolonged exposure to hyperglycemia, will render individuals with early-onset T2DM more vulnerable once these complications develop, particularly DR, with the possibility of more severe DR such as proliferative diabetic retinopathy (PDR), which may directly impact vision [4]. This emphasizes the importance of identifying clinical and biochemical predictors of the severity of DR in this population of early-onset T2DM for timely intervention and to protect vision. There are

a number of studies that have identified the risk factors associated with the development and progression of DR including duration of diabetes, poor glycemic control based on HbA1C, hypertension, nephropathy, dyslipidemia, and anemia [5]; however, these risk factors in the context of early-onset T2DM is not fully characterized in current literature. In particular, subclinical biochemical abnormalities including high urine microalbumin, abnormal lipid profiles (i.e., high triglycerides, low HDL), and low hemoglobin might be appropriate as early markers for microvascular damage or disease progression [6].

Early evidence suggests that anemia, which often goes underestimated in outpatient populations, is heavily correlated with the level of severity of diabetic retinopathy [7]. Decreased hemoglobin concentration may result in retinal hypoxia, which in turn indirectly affects retinal damage and neovascularization in proliferative disease [8]. Similarly, microalbuminuria is a widely accepted indicator of endothelial dysfunction and has been associated with concurrent microvascular complications, including diabetic retinopathy and nephropathy. Elevated HbA1C is clearly one central risk factor and it indicates a lack of glycemic control over time, which also sharply correlates with the risk of progression from non-proliferative diabetic retinopathy (NPDR) to proliferative diabetic retinopathy (PDR) [9]. Lipid perturbations including hypertriglyceridemia and low HDL cholesterol levels have also been associated with changes in retinal vascularity, but their abilities to predict PDR remains mixed. Pinpointing the relationships between these biochemical markers of risk and retinopathy severity may help to stratify risk in patient management, treatment course delivery, and ophthalmologic screening frequency in high-risk populations [10].

The study seeks to assess clinical and biochemical predictors of retinopathy severity in adults with early-onset T2DM, specifically identifying associations to PDR progression. This study will provide evidence regarding few of the important clinical markers collected including age at diabetes diagnosis, diabetes duration, hemoglobin, HbA1C, urine microalbumin, and lipid profiles from blood samples, that could be used for improved timely detection and tailored interventions for this population at risk. This study adds to ˙the expanding area of research recognizing the need for aggressive and timely screening and intervention protocols for younger adults with type 2 diabetes.

Methodology

Study Design and Setting: This was a descriptive cross-sectional study conducted in the Department of Ophthalmology at a tertiary care government medical college in South India. The study was carried out over a two-year period, from January 2019 to December 2020.

Study Population: The study included 94 individuals diagnosed with early-onset type 2 diabetes mellitus (T2DM) who also had clinically diagnosed diabetic retinopathy (DR). Early-onset T2DM was defined as diabetes diagnosed before the age of 40 years.

Eligibility Criteria

Inclusion Criteria

- Confirmed diagnosis of type 2 diabetes mellitus with onset before 40 years of age.
- Presence of any grade of diabetic retinopathy, as confirmed by retinal examination.
- Age ≥18 years at the time of evaluation.
- Willingness to participate and provide informed consent.

Exclusion Criteria

- Patients with type 1 diabetes, gestational diabetes, or secondary diabetes due to pancreatic disorders, steroid use, or genetic syndromes.
- History of ocular trauma, intraocular surgery, or other retinal diseases unrelated to diabetes.
- Incomplete clinical or laboratory records.

Data Collection: Data were collected through structured interviews, clinical examinations, and review of medical records. The collection process focused on three key domains: demographic and clinical characteristics, ophthalmic evaluation, and biochemical investigations.

Demographic and Clinical Parameters: Information regarding the following variables was systematically recorded:

- **Demographics**: Age, sex, age at diagnosis of type 2 diabetes mellitus, and total duration of diabetes.
- **Lifestyle Factors**: Smoking status and alcohol consumption.
- **Co-morbidities**: Presence of hypertension, hyperlipidemia, and obesity.
- **Diabetes-Related Complications**:
    - **Microvascular**: Neuropathy and nephropathy.
    - **Macrovascular**: Coronary artery disease, cerebrovascular accidents, and peripheral arterial disease.

Ophthalmic Evaluation: A comprehensive ophthalmologic assessment was performed for all participants. The examination included:

- **Basic Ocular Assessments**:
    - Visual acuity testing.
    - Slit-lamp biomicroscopy˙.
    - Intraocular pressure measurement.

- Dilated fundus examination.

- **Retinal Evaluation**:
  - Slit-lamp biomicroscopy using a 78D lens**.**
  - Imaging with Spectral-Domain Optical Coherence Tomography (OCT)**.**
  - The eye with the more advanced stage of diabetic retinopathy (DR) was considered for severity classification. Retinopathy was graded according to the Early Treatment Diabetic Retinopathy Study (ETDRS) classification system:
    - **Non-Proliferative Diabetic Retinopathy (NPDR)**: Presence of microaneurysms, intraretinal hemorrhages, venous beading, cotton wool spots, and intraretinal microvascular abnormalities.
    - **Proliferative Diabetic Retinopathy (PDR)**: Evidence of neovascularization, preretinal or vitreous hemorrhages, and fibrovascular proliferation.

Biochemical Investigations

Laboratory tests performed included:

- Hemoglobin (Hb) and erythrocyte sedimentation rate (ESR)
- Fasting blood sugar (FBS), postprandial blood sugar (PPBS), and glycated hemoglobin (HbA1C)
- Blood urea and serum creatinine
- Urine microalbumin levels for nephropathy assessment
- Fasting lipid profile: total cholesterol, triglycerides (TG), low-density lipoprotein (LDL), high-density lipoprotein (HDL), and very-low-density lipoprotein (VLDL)

Statistical Analysis: Data were analyzed using SPSS version 27.0. Descriptive statistics were employed to summarize the demographic, clinical, ophthalmic, and biochemical characteristics of the study population. Continuous variables were expressed as mean ± standard deviation and compared between groups using the independent t-test. Categorical variables were presented as frequencies and percentages, and comparisons were made using the Chi-square test or Fisher's exact test, where appropriate. To determine the independent clinical and biochemical predictors of proliferative diabetic retinopathy (PDR), multivariate logistic regression analysis was performed. A p-value of less than 0.05 was considered statistically significant for all analysis.

Results

The results of this study revealed a high prevalence of moderate to severe non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR) among individuals with early-onset type 2 diabetes. Significant associations were observed between PDR and longer diabetes duration, nephropathy, poor glycemic control (HbA1c), and elevated LDL levels.

Table 1 shows the demographic and clinical characteristics of the 94 participants with early-onset type 2 diabetes mellitus. The mean age of the study population was 42.3 ± 6.5 years, with an average age at diagnosis of diabetes being 34.1 ± 4.2 years and a mean disease duration of 8.2 ± 3.1 years. A male predominance was noted, accounting for 59.6% of the cases. Lifestyle risk factors such as smoking and alcohol use were present in 23.4% and 19.1% of participants, respectively. More than half of the patients (51.1%) had hypertension, followed by hyperlipidemia in 41.5% and obesity in 35.1%. Microvascular complications were notable, with neuropathy present in 30.9% and nephropathy in 26.6% of individuals. Additionally, macrovascular complications were observed, including coronary artery disease in 13.8%, cerebrovascular accidents in 7.4%, and peripheral arterial disease in 11.7% of cases. Overall, Table 1 demonstrates a high prevalence of cardiovascular risk factors and diabetes-related complications in this relatively young diabetic population.

Table 1: Demographic and Clinical Characteristics of the Study Population (N = 94)

Variable	Mean ± SD / n (%)
Age (years)	42.3 ± 6.5
Age at diagnosis of T2DM (years)	34.1 ± 4.2
Duration of diabetes (years)	8.2 ± 3.1
Sex (Male)	56 (59.6%)
Smoking	22 (23.4%)
Alcohol use	18 (19.1%)
Hypertension	48 (51.1%)
Hyperlipidemia	39 (41.5%)
Obesity (BMI ≥ 30)	33 (35.1%)
Neuropathy	29 (30.9%)
Nephropathy	25 (26.6%)
Coronary artery disease (CAD)	13 (13.8%)

Cerebrovascular accident (CVA)	7 (7.4%)
Peripheral arterial disease	11 (11.7%)

Table 2 shows the distribution of diabetic retinopathy (DR) severity among the 94 study participants. None of the individuals were free of retinopathy, as all had some form of DR by study inclusion criteria. The majority of patients were diagnosed with non-proliferative diabetic retinopathy (NPDR), with 27.7% having mild NPDR, 33.0% moderate NPDR, and 20.2% severe NPDR. Proliferative diabetic retinopathy (PDR), representing the most advanced stage, was observed in 19.1% of the participants. Overall, Table 2 highlights that more than half of the patients had moderate to severe NPDR or PDR, indicating a significant burden of advanced retinal disease in this early-onset diabetic population.

Table 2: Distribution of Diabetic Retinopathy Severity

Diabetic Retinopathy Grade	Number of Patients (%)
No Retinopathy (for context)	0 (0%)
Mild NPDR	26 (27.7%)
Moderate NPDR	31 (33.0%)
Severe NPDR	19 (20.2%)
PDR	18 (19.1%)
Total	94 (100%)

Table 3 presents the biochemical profile of the study population, reflecting both glycemic control and systemic metabolic status. The mean hemoglobin level was 12.9 ± 1.6 g/dL, and the erythrocyte sedimentation rate (ESR) was elevated at 24.3 ± 10.8 mm/hr, suggesting underlying inflammation. Glycemic parameters revealed poor diabetes control, with a mean fasting blood sugar (FBS) of 154.6 ± 39.2 mg/dL, postprandial blood sugar (PPBS) of 221.8 ± 58.4 mg/dL, and an elevated HbA1c of 8.7 ± 1.4%, indicating chronic hyperglycemia. Renal function markers were within borderline ranges, with blood urea at 34.7 ± 12.3 mg/dL, serum creatinine at 1.1 ± 0.3 mg/dL, and urine microalbumin at 42.5 ± 18.6 mg/g, pointing to early nephropathy in some cases. Lipid profile analysis showed elevated mean levels of total cholesterol (198.2 ± 32.1 mg/dL), triglycerides (179.4 ± 45.7 mg/dL), LDL (118.9 ± 28.5 mg/dL), and VLDL (35.9 ± 11.2 mg/dL), while HDL was relatively low at 41.2 ± 9.3 mg/dL. Overall, Table 3 indicates a pattern of poor metabolic control and increased cardiovascular risk in this cohort of early-onset diabetic patients.

Table 3: Biochemical Parameters of the Study Population

Parameter	Mean ± SD
Hemoglobin (g/dL)	12.9 ± 1.6
ESR (mm/hr)	24.3 ± 10.8
FBS (mg/dL)	154.6 ± 39.2
PPBS (mg/dL)	221.8 ± 58.4
HbA1c (%)	8.7 ± 1.4
Blood Urea (mg/dL)	34.7 ± 12.3
Serum Creatinine (mg/dL)	1.1 ± 0.3
Urine Microalbumin (mg/g)	42.5 ± 18.6
Total Cholesterol (mg/dL)	198.2 ± 32.1
Triglycerides (mg/dL)	179.4 ± 45.7
LDL (mg/dL)	118.9 ± 28.5
HDL (mg/dL)	41.2 ± 9.3
VLDL (mg/dL)	35.9 ± 11.2

Table 4 shows the association between selected clinical variables and the severity of diabetic retinopathy among patients with NPDR and PDR. The mean duration of diabetes was significantly longer in the PDR group (9.7 ± 3.4 years) compared to the NPDR group (7.8 ± 2.9 years; $p = 0.01$). Nephropathy was significantly more prevalent in patients with PDR (61.1%) than in those with NPDR (18.4%), with a highly significant p-value (<0.001). Similarly, HbA1c levels were higher in the PDR group (9.6 ± 1.5%) compared to NPDR (8.5 ± 1.2%; $p = 0.003$), indicating poorer glycemic control. LDL cholesterol levels were also significantly elevated in PDR patients (138.7 ± 30.3 mg/dL) compared to NPDR patients (112.4 ± 26.1 mg/dL; $p = 0.004$). Although hypertension was more common in PDR (66.7%) than NPDR (47.4%), the association was not statistically significant ($p = 0.15$). These findings suggest that poor metabolic control and nephropathy are linked to more severe retinopathy.

Table 4: Association Between Clinical Factors and Severity of Diabetic Retinopathy (NPDR vs PDR)			
Clinical Variable	**NPDR (n = 76)**	**PDR (n = 18)**	**p-value**
Duration of diabetes (years)	7.8 ± 2.9	9.7 ± 3.4	0.01
Hypertension (%)	36 (47.4%)	12 (66.7%)	0.15
Nephropathy (%)	14 (18.4%)	11 (61.1%)	<0.001
HbA1c (%)	8.5 ± 1.2	9.6 ± 1.5	0.003
LDL (mg/dL)	112.4 ± 26.1	138.7 ± 30.3	0.004

Table 5 presents the results of a multivariate logistic regression analysis identifying independent predictors of proliferative diabetic retinopathy (PDR). Longer duration of diabetes was significantly associated with higher odds of PDR, with each additional year increasing the risk by 22% (OR: 1.22; 95% CI: 1.05–1.41; p = 0.009). The presence of nephropathy emerged as a strong predictor, with affected individuals having nearly five times the risk of developing PDR compared to those without nephropathy (OR: 4.71; 95% CI: 1.72–12.89; p = 0.002). Higher HbA1c levels were also associated with increased PDR risk, with each 1% rise in HbA1c raising the odds by 58% (OR: 1.58; 95% CI: 1.12–2.24; p = 0.01). Additionally, for every 10 mg/dL increase in LDL cholesterol, the risk of PDR increased by 34% (OR: 1.34; 95% CI: 1.09–1.64; p = 0.004). These findings underscore the role of poor glycemic and lipid control, as well as nephropathy, in the progression to PDR.

Table 5: Multivariate Logistic Regression for Predictors of Proliferative Diabetic Retinopathy		
Predictor Variable	**Adjusted OR (95% CI)**	**p-value**
Duration of diabetes (per year)	1.22 (1.05 – 1.41)	0.009
Nephropathy	4.71 (1.72 – 12.89)	0.002
HbA1c (per 1% increase)	1.58 (1.12 – 2.24)	0.01
LDL (per 10 mg/dL increase)	1.34 (1.09 – 1.64)	0.004

Discussion

The current study documents a high burden of sight-threatening diabetic retinopathy (DR), specifically moderate-to-severe non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR), in individuals with early-onset type 2 diabetic mellitus (T2DM). The mean age of our participants was 42.3 ± 6.5 years, with a mean T2DM duration of 8.2 ± 3.1 years. Despite a younger average age, participants demonstrated substantial levels of retinal morbidities. This emphasizes the aggressive natural history in patients with early-onset T2DM, which has been reported in other populations as well. Yun et al. (2016) found a higher incidence of DR and faster progression of DR in early-onset T2DM compared with late-onset T2DM cases, as they suggested patients with late-onset T2DM had reduced lifetime glycemic exposure and developed metabolic dysfunction later in life.

The present study found that the significant associations were duration of diabetes, nephropathy, poor glycemic control (HbA1c levels), and risk of PDR. Our study data showed results that were similar to the Wisconsin Epidemiologic Study of Diabetic Retinopathy (WESDR) which demonstrated that longer duration of diabetes and being higher HbA1c, which resulted in a strong odd of predicting progression from NPDR to PDR (Klein et al.,1989) [11]. Also consistent with our study data is the Diabetes Control and Complications Trial (DCCT), which then longitudinally evaluated with long-term follow-up the Epidemiology of Diabetes Interventions and Complications (EDIC) which showed evidence that poor glycemic control can develop a higher risk of microvascular complications, such as DR [12].

Our findings also support a robust independent association between diabetic nephropathy and advanced retinopathy. In our study, the presence of nephropathy had an adjusted odds ratio (OR) of 4.71 (p = 0.002) for predicting PDR, highlighting the role of systemic microvascular damage. This is consistent with the work of Lee et al., (2011), who reported that microalbuminuria and overt nephropathy significantly predicted the progression of DR [13]. Such associations likely reflect shared pathophysiological mechanisms, particularly endothelial dysfunction, oxidative stress, and chronic low-grade inflammation, all of which are common in both nephropathy and retinopathy.

Elevated LDL cholesterol was also significantly associated with PDR in our cohort, with mean LDL levels notably higher among patients with PDR than those with NPDR (138.7 ± 30.3 mg/dL vs. 112.4 ± 26.1 mg/dL; p = 0.004). This finding aligns with outcomes from major clinical trials such as the FIELD and ACCORD Eye studies. These trials demonstrated that dyslipidemia, particularly elevated LDL and triglyceride levels, was associated with increased risk of hard exudates and progression to sight-threatening DR (Chew et al., 2010; Keech et al., 2007) [14,15]. These findings reinforce the importance of lipid control as part of the strategy to prevent DR progression.

Our study showed that there was a higher baseline prevalence of hypertension in the PDR group, but

not at a statistically significant level ($p = 0.15$). However, landmark studies like the UK Prospective Diabetes Study (UKPDS) have demonstrated additive associations of hypertension accelerating DR development, particularly when poor glycemic control existed in conjunction (UKPDS Group, 1998) [16]. Although we may not have found these associations because of the smaller sample size, the importance of hypertension management for DR prevention must be emphasized. Overall, our study emphasizes that early-onset T2DM patients are at heightened risk for DR and more vulnerable to rapid clinical progression. The important associations of poor glycemic control, nephropathy, and dyslipidemia with PDR highlight the importance of full metabolic surveillance and early ophthalmologic screening. Our findings demonstrate the need for aggressive intervention and screening programs in younger populations with diabetes to prevent irreversible visual disability.

Conclusion

This study demonstrates a very high prevalence of vision-threatening diabetic retinopathy within individuals with early-onset type 2 diabetes mellitus. Proliferative DR was closely related to longer diabetes duration, poorer glycemic control (higher HbA1c), nephropathy, and higher LDL. These results show the necessity for early identification, regular ophthalmic screening, monitoring of glycemia and lipid levels, and aggressive management to prevent or delay retinopathy progression. Nephropathy was noted to be a strong predictor for severity of DR, supporting the argument for extra vigilance for microvascular complications in individuals with diabetes. Proactive multidisciplinary interventions are essential in order to diminish visual morbidity in younger diabetic patients.

References

1. Zheng Y, He M, Congdon N. The worldwide epidemic of diabetic retinopathy. Indian journal of ophthalmology. 2012 Sep 1;60(5):428-31.
2. Sabanayagam C, Yip W, Ting DS, Tan G, Wong TY. Ten emerging trends in the epidemiology of diabetic retinopathy. Ophthalmic epidemiology. 2016 Jul 3;23(4):209-22.
3. Wilmot E, Idris I. Early onset type 2 diabetes: risk factors, clinical impact and management. Therapeutic advances in chronic disease. 2014 Nov;5(6):234-44.
4. Danis RP, Davis MD. Proliferative diabetic retinopathy. InDiabetic retinopathy 2008 Oct 8 (pp. 29-65). Totowa, NJ: Humana Press.
5. Longo-Mbenza B, Muaka MM, Mbenza G, Mbungu-Fuele S, Mabwa-Mbalanda L, Nzuzi-Babeki V, Mbadi-A-Sungu J. Risk factors of poor control of HBA1c and diabetic retinopathy: Paradox with insulin therapy and high values of HDL in African diabetic patients. International Journal of Diabetes and Metabolism. 2008 Feb;16(2).
6. Garg JP, Bakris GL. Microalbuminuria: marker of vascular dysfunction, risk factor for cardiovascular disease. Vascular medicine. 2002 Feb;7(1):35-43.
7. Javitt JC, Aiello LP. Cost-effectiveness of detecting and treating diabetic retinopathy. Annals of internal medicine. 1996 Dec 1;125(11):939.
8. Arjamaa O, Nikinmaa M. Oxygen-dependent diseases in the retina: role of hypoxia-inducible factors. Experimental eye research. 2006 Sep 1;83(3):473-83.
9. Shruti B. A Hospital Based Study to Evaluate the Role of Glycosylated Haemoglobin (HbA1c) on Sight Threatening Diabetic Retinopathy (Master's thesis, Rajiv Gandhi University of Health Sciences (India)).
10. Jenkins AJ, Joglekar MV, Hardikar AA, Keech AC, O'Neal DN, Januszewski AS. Biomarkers in diabetic retinopathy. The review of diabetic studies: RDS. 2015 Aug 10;12(1-2):159.
11. Klein R. The Wisconsin epidemiologic study of diabetic retinopathy. Archives of Ophthalmology. 1989 Feb 1;107(2):244.
12. Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications (DCCT/EDIC) Study Research Group. Intensive diabetes treatment and cardiovascular disease in patients with type 1 diabetes. New England Journal of Medicine. 2005 Dec 22;353(25):2643-53.
13. Lee WJ, Sobrin L, Lee MJ, Kang MH, Seong M, Cho H. The relationship between diabetic retinopathy and diabetic nephropathy in a population-based study in Korea (KNHANES V-2, 3). Investigative ophthalmology & visual science. 2014 Oct 1;55(10):6547-53.
14. Chew EY, Ambrosius WT, Davis MD. ACCORD Eye Study Group Effects of medical therapies on retinopathy progression in type 2 diabetes. N Engl J Med. 2010 Jul;363(3):233-44.
15. Keech AC, Mitchell P, Summanen PA, O'Day J, Davis TM, Moffitt MS, Taskinen MR, Simes RJ, Tse D, Williamson E, Merrifield A. Effect of fenofibrate on the need for laser treatment for diabetic retinopathy (FIELD study): a randomised controlled trial. The Lancet. 2007 Nov 17;370(9600):1687-97.
16. UK Prospective Diabetes Study Group. Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. Bmj. 1998 Sep 12;317(7160):703-13