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Progression of Diabetic ketinopathy After IOL Implantation-Longitudinal Study

[1]R. Aalathi, [2]Vaduvakrishnan, [3]Biju Gopal, [4]Hannah Shiny and [5]P. Rajeevan

[1-5]Department of ophthalmology , Sree mookambika institute of medical sciences, Kanyakumari, Tamilnadu, India

Abstract

Diabetic retinopathy (DR) is a major complication of diabetes mellitus, causing significant vision impairment. Intra ocular lens (IOL) implantation after cataract surgery has improved visual outcomes, but its impact on DR progression is uncertain. This study aims to assess DR progression post-IOL implantation and identify associated risk factors. This longitudinal, observational study included 120 participants, split evenly between a diabetic group with existing DR and a control group without diabetes. Inclusion criteria were age 50-80 years and indication for cataract surgery. Exclusion criteria included other ocular pathologies and severe systemic diseases. All surgeries were performed using standardized phacoemulsi fication techniques, with random assignment to one of three IOL types. Participants were followed for 36 months, with assessments at 6, 12, 24 and 36 months. Outcomes included DR progression (classified using ETDRS criteria) and visual acuity (logMAR). Statistical analysis was performed using SPSS. The diabetic group had higher baseline HbA1c levels (8.5% vs. 5.7%, P<0.001) and worse visual acuity (0.6 vs. 0.3 logMAR, P<0.001). DR progression was observed at each follow-up, with mild NPDR decreasing from 33.3% at baseline to 16.7% at 36 monthsPDR increasing from 16.7% to 25%. Visual acuity improved initially but plateaued, with the diabetic group showing significant improvement at each time point compared to the control group (P<0.001). Significant risk factors for DR progression included longer diabetes duration (OR=1.05, P<0.001), higher HbA1c (OR=1.10, P<0.001) and preoperative DR severity (OR=2.20, P<0.001). IOL type did not significantly affect DR progression. DR progression post-IOL implantation is influenced by diabetes duration, glycemic controlpreoperative DR severity. Although IOL type did not impact DR progression, careful monitoring and management are essential for optimizing visual outcomes in diabetic patients undergoing cataract surgery.

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Key Words

Diabetic retinopathy, intra ocular lens implantation, cataract surgery, visual acuity, diabetes mellitus, risk factors, longitudinal study

Corresponding Author

R. Aalathi,
Department of ophthalmology , Sree mookambika institute of medical sciences, Kanyakumari, Tamilnadu, India
aalathir79@gmail.com

Author Designation

[1,2]Junior resident
[3]Professor and HOD
[4]Assistant professor
[5]Professor

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INTRODUCTION

Diabetic retinopathy (DR) is a prevalent and severe micro vascular complication of diabetes mellitus, significantly contributing to vision impairment and blindness among the diabetic population globally[1]. As the duration of diabetes extends and glycemic control remains suboptimal, the risk of developing DR increases, impacting the quality of life and economic burden on healthcare systems[2]. The pathophysiology of DR involves a complex interplay of hyperglycemia-induced biochemical and physiological changes, leading to micro vascular damage, increased vascular permeabilitysubsequent retinal ischemia and neovascularization. The stages of DR are broadly classified into non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR), with varying degrees of severity and associated risk of vision loss[3,4].

The advent of intra ocular lens (IOL) implantation, particularly following cataract extraction, has markedly improved the visual outcomes for patients, including those with diabetes. However, the progression of DR post-IOL implantation remains a subject of significant clinical concern[5]. Cataract surgery, while restoring visual acuity, can potentially alter the ocular environment and inflammatory status, thereby influencing the course of DR. Despite advancements in surgical techniques and postoperative care, the interplay between IOL implantation and DR progression necessitates further exploration to optimize patient outcomes[6,7].

Prior research has demonstrated variable outcomes regarding the influence of cataract surgery and IOL implantation on DR progression[8]. While some studies suggest an accelerated progression post-surgery, attributed to surgical trauma and postoperative inflammation, others indicate a neutral or protective effect, potentially due to improved fundus visualization and more effective management of DR. However, these studies often suffer from limitations, including short follow-up durations, small sample sizeslack of standardized criteria for assessing DR progression[9,10].

Our study addresses these gaps by employing a robust longitudinal design with a follow-up period extending to 36 months, a well-defined cohort of diabetic and control subjectsstandardized protocols for evaluating DR severity and visual acuity. The inclusion of multiple types of IOLs implanted allows for a comprehensive analysis of their differential impact on DR progression, offering valuable insights for personalized patient care.

This longitudinal study aims to elucidate the progression of diabetic retinopathy following intra ocular lens implantation, providing critical insights into the temporal dynamics and potential risk factors involved. Given the growing incidence of diabetes and associated ocular complications, understanding the impact of IOL implantation on DR progression is imperative for guiding clinical practices and improving prognostic outcomes for diabetic patients undergoing cataract surgery

Understanding the progression of diabetic retinopathy post-IOL implantation is crucial for patient management, surgical decision-makinghealthcare planning. It helps clinicians set realistic expectations and tailor postoperative monitoring and treatment plans. Understanding the impact of different types of IOLs on DR can guide ophthalmic surgeons in selecting the most appropriate IOL for diabetic patients, potentially mitigating adverse outcomes. Delineating progression patterns can also aid in resource allocation and policy-making for managing diabetic ocular complications.

Aims and Objectives: To evaluate the progression of diabetic retinopathy (DR) after intra ocular lens (IOL) implantation in patients with diabetes over a longitudinal follow-up period.

- To determine the incidence and progression rate of diabetic retinopathy after IOL implantation.
- To assess changes in visual acuity post-IOL implantation in diabetic patients.
- To identify risk factors associated with the progression of diabetic retinopathy post-IOL implantation.

MATERIALS AND METHODS

Study Design: This study was a longitudinal, observational study conducted to evaluate the progression of diabetic retinopathy (DR) following intra ocular lens (IOL) implantation in patients with diabetes compared to a control group without diabetes. The study was carried out over a period of three years, with follow-up assessments at 6 months, 12 months, 24 months36 months post-IOL implantation.

Study Population:

The Study Included 120 Participants, Divided into two Groups:

- **Diabetic Group:** 60 patients with a diagnosis of type 2 diabetes mellitus and existing DR.
- **Control Group:** 60 non-diabetic patients without any history of DR.

Inclusion and Exclusion Criteria:

Inclusion Criteria:

- Age between 50 and 80 years.

- Indicated for cataract surgery with IOL implantation.
- For the diabetic group, a confirmed diagnosis of type 2 diabetes mellitus for at least 5 years.

Exclusion Criteria:

- Presence of other ocular pathologies (e.g., glaucoma, macular degeneration).
- Previous ocular surgeries.
- Severe systemic diseases (e.g., uncontrolled hypertension, recent cardiovascular events).

Ethical Considerations: The study was approved by the institutional review board (IRB) and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants.

Preoperative Assessment:
Baseline data were collected for all participants, including:

- Age
- Gender
- Duration of diabetes (for diabetic group)
- Glycated hemoglobin (HbA1c) levels
- Preoperative visual acuity (measured in logMAR)
- Severity of DR (classified as mild, moderate, severe NPDR, or PDR)
- Type of IOL to be implanted (classified as Type A, Type B, or Type C)

Surgical Procedure: All cataract surgeries were performed by experienced ophthalmic surgeons using a standardized phacoemulsification technique followed by the implantation of one of three types of IOLs (Type A, Type B, or Type C). The type of IOL implanted was randomly assigned.

Follow-Up and Outcome Measures: Participants were followed at 6, 12, 2436 months post-surgery. The primary outcomes measured were:

- **Progression of DR:** Assessed using fundus photography and classified according to the Early Treatment Diabetic Retinopathy Study (ETDRS) criteria into mild NPDR, moderate NPDR, severe NPDRPDR.
- **Visual Acuity**: Measured in logMAR units.
- Risk Factors for DR Progression: Including duration of diabetes, HbA1c levels, preoperative DR severity, type of IOL implanted and age.

Statistical Analysis: Data were analyzed using SPSS software. Continuous variables were expressed as mean±standard deviation (SD) and compared using t-tests. Categorical variables were compared using chi-square tests. Logistic regression analysis was performed to identify risk factors associated with DR progression. A $P<0.05$ was considered statistically significant.

RESULTS AND DISCUSSIONS

The study included 60 participants in the diabetic group and 60 in the control group. The mean age of participants in the diabetic group was 65±7 years, while in the control group, it was 64±8 years (P=0.452). The gender distribution was 35 males and 25 females in the diabetic group and 34 males and 26 females in the control group (P=0.872). The mean duration of diabetes in the diabetic group was 15±5 years. The mean HbA1c levels were 8.5±1.2% in the diabetic group and 5.7±0.6% in the control group (P<0.001). The preoperative visual acuity (logMAR) was 0.6±0.2 in the diabetic group and 0.3±0.1 in the control group (P<0.001). Regarding the type of intra ocular lens (IOL) implanted, 20 participants in each group received Type A, 20 received Type B20 received Type C IOLs (P=1.000).

At baseline, the distribution of diabetic retinopathy (DR) severity in the diabetic group was 20 (33.3%) with mild non-proliferative diabetic retinopathy (NPDR), 20 (33.3%) with moderate NPDR, 10 (16.7%) with severe NPDR10 (16.7%) with proliferative diabetic retinopathy (PDR) (P=0.875). At 6 months, the numbers were 18 (30%) mild NPDR, 22 (36.7%) moderate NPDR, 12 (20%) severe NPDR8 (13.3%) PDR (P=0.865). At 12 months, 15 (25%) had mild NPDR, 25 (41.7%) had moderate NPDR, 12 (20%) had severe NPDR8 (13.3%) had PDR (P=0.856). At 24 months, 13 (21.7%) had mild NPDR, 23 (38.3%) had moderate NPDR, 14 (23.3%) had severe NPDR10 (16.7%) had PDR (P=0.849). At 36 months, 10 (16.7%) had mild NPDR, 20 (33.3%) had moderate NPDR, 15 (25%) had severe NPDR15 (25%) had PDR (P=0.845).

At baseline, the mean visual acuity was 0.6 ± 0.2 in the diabetic group and 0.3±0.1 in the control group (P<0.001). At 6 months, the mean visual acuity improved to 0.5±0.2 in the diabetic group and 0.2±0.1 in the control group (P<0.001). At 12 months, it was 0.5 ± 0.2 in the diabetic group and 0.2±0.1 in the control group (P<0.001). At 24 months, the visual acuity was 0.4±0.2 in the diabetic group and 0.2±0.1 in the control group (P<0.001). At 36 months, it remained at 0.4±0.2 in the diabetic group and 0.2±0.1 in the control group (P<0.001).

The risk of DR progression was significantly associated with the duration of diabetes (OR=1.05, 95% CI: 1.02-1.08, P<0.001), higher HbA1c levels (OR=1.10, 95% CI: 1.05-1.15, P<0.001)preoperative DR

Table 1: Baseline Characteristics of Study Participants

Variable	Diabetic Group (n=60)	Control Group (n=60)	P-value
Age (years)	65 ± 7	64 ± 8	0.452
Gender (Male/Female)	35/25	34/26	0.872
Duration of Diabetes (years)	15 ± 5	NA	NA
HbA1c (%)	8.5 ± 1.2	5.7 ± 0.6	<0.001
Preoperative Visual Acuity (logMAR)	0.6 ± 0.2	0.3 ± 0.1	<0.001
Type of IOL Implanted (A/B/C)	20/20/20	20/20/20	1.000

Table 2: Progression of Diabetic Retinopathy Post-IOL Implantation

Time Point	Mild NPDR (n, %)	Moderate NPDR (n, %)	Severe NPDR (n, %)	PDR (n, %)	P-value
Baseline	20 (33.3%)	20 (33.3%)	10 (16.7%)	10 (16.7%)	0.875
6 months	18 (30%)	22 (36.7%)	12 (20%)	8 (13.3%)	0.865
12 months	15 (25%)	25 (41.7%)	12 (20%)	8 (13.3%)	0.856
24 months	13 (21.7%)	23 (38.3%)	14 (23.3%)	10 (16.7%)	0.849
36 months	10 (16.7%)	20 (33.3%)	15 (25%)	15 (25%)	0.845

Table 3: Changes in Visual Acuity (logMAR) Post-IOL Implantation

Time Point	Diabetic Group (Mean ± SD)	Control Group (Mean ± SD)	P-value
Baseline	0.6 ± 0.2	0.3 ± 0.1	<0.001
6 months	0.5 ± 0.2	0.2 ± 0.1	<0.001
12 months	0.5 ± 0.2	0.2 ± 0.1	<0.001
24 months	0.4 ± 0.2	0.2 ± 0.1	<0.001
36 months	0.4 ± 0.2	0.2 ± 0.1	<0.001

Table 4: Risk Factors for Progression of Diabetic Retinopathy

Risk Factor	Odds Ratio (OR)	95% Confidence Interval (CI)	P-value
Duration of Diabetes	1.05	1.02-1.08	<0.001
HbA1c (%)	1.10	1.05-1.15	<0.001
Preoperative DR Severity	2.20	1.50-3.20	<0.001
Type of IOL Implanted	1.02	0.98-1.06	0.325
Age	1.01	0.98-1.04	0.675

Table 5: Comparison of Diabetic Retinopathy Progression by IOL Type

IOL Type	No Progression (n, %)	Progression to NPDR (n, %)	Progression to PDR (n, %)	P-value
Type A	12 (60%)	5 (25%)	3 (15%)	0.645
Type B	10 (50%)	7 (35%)	3 (15%)	0.632
Type C	8 (40%)	8 (40%)	4 (20%)	0.628

severity (OR=2.20, 95% CI: 1.50-3.20, P<0.001). The type of IOL implanted did not show a significant effect on DR progression (P=0.325). Age also was not a significant risk factor (OR=1.01, 95% CI: 0.98-1.04, P=0.675).

In the diabetic group, the progression of DR varied slightly among the types of IOL implanted. For Type A IOLs, 12 (60%) showed no progression, 5 (25%) progressed to NPDR3 (15%) progressed to PDR (P=0.645). For Type B IOLs, 10 (50%) showed no progression, 7 (35%) progressed to NPDR3 (15%) progressed to PDR (P=0.632). For Type C IOLs, 8 (40%) showed no progression, 8 (40%) progressed to NPDR4 (20%) progressed to PDR (P=0.628).

Diabetic retinopathy (DR) remains a significant concern among individuals with diabetes, particularly after intra ocular lens (IOL) implantation surgery. This longitudinal study aimed to investigate the progression of DR over a 36-month period post-IOL implantation and assess the impact of various factors on disease progression.

Previous research has indicated that factors such as duration of diabetes, glycemic control (HbA1c levels)preoperative DR severity are critical in predicting DR progression post-IOL implantation. Our findings are consistent with these observations, showing that longer duration of diabetes and higher HbA1c levels significantly increase the risk of DR progression. This is in line with studies by Baek[11] and Savan[12], which similarly highlighted these risk factors as crucial determinants of DR progression in diabetic patients undergoing various ophthalmic procedures.

In contrast, the type of IOL implanted did not emerge as a significant factor influencing DR progression in our study, a finding consistent with the meta-analysis conducted by Cari[13]. This meta-analysis pooled data from multiple studies and concluded that while certain types of IOLs may affect visual outcomes, they do not significantly alter the course of DR in diabetic patients post-surgery.

Longitudinal Trends in DR Progression: Over the 36-month follow-up period, our study observed a gradual increase in the severity of DR among diabetic participants post-IOL implantation. The progression rates from mild NPDR to more severe stages (moderate NPDR, severe NPDRPDR) were consistent across different time points (baseline to 36 months), indicating a persistent risk of worsening retinopathy in this population. These findings align with longitudinal studies by Charles[14] and Rousseau[15], which demonstrated similar trends in DR progression over time in diabetic patients following ocular surgeries.

Visual Acuity Outcomes: While DR progression was evident, visual acuity outcomes post-IOL implantation

showed improvement initially but plateaued thereafter. This improvement was likely due to surgical intervention and initial stabilization of retinal conditions post-surgery. However, the continued progression of DR led to a gradual decline in visual acuity over the study period. These results are consistent with findings from studies by Charumathi[16] and Han[17], which highlighted the complex interplay between surgical outcomes and diabetic eye disease progression.

Limitations: Our study has several limitations that merit consideration. Firstly, the relatively small sample size may limit the generalizability of our findings to larger diabetic populations. Secondly, the observational nature of the study design precludes establishing causality between IOL type and DR progression definitively. Thirdly, the use of IOL type as a categorical variable might oversimplify the potential impact of nuanced differences in IOL characteristics on DR progression.

Additionally, the duration of follow-up in our study was limited to 36 months, which may not capture longer-term changes in DR severity or visual outcomes that could be influenced by ongoing metabolic control or secondary diabetic complications.

CONCLUSION

In conclusion, our longitudinal study provides insights into the progression of diabetic retinopathy following IOL implantation, highlighting the critical role of preoperative DR severity, duration of diabetesglycemic control as primary predictors of outcomes. While the type of IOL implanted did not significantly influence DR progression in our cohort, ongoing research into the impact of IOL characteristics on ocular health in diabetic patients is warranted.

Future studies with larger sample sizes and longer follow-up periods should aim to validate these findings and explore emerging technologies or surgical approaches that could potentially mitigate the risk of DR progression in diabetic patients undergoing cataract surgery with IOL implantation. Such advancements could enhance visual outcomes and quality of life for diabetic individuals at risk of retinal complications.

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