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Study to Evaluate Changes in Central Macular Thickness Following Uncomplicated Small Incision Cataract Surgery in Diabetic and Non-Diabetic Patients

Dr. Gaurav Kumar[1], Dr. Saroj Bala[2], Dr. Karamjit Singh[3], Dr. Anubha Bhatti[4], Dr. Manveen Kaur[5]

[1]Junior Resident, Regional Institute of Ophthalmology, Government Medical College, Amritsar, Punjab, India
ggaurav29[at]gmail.com

[2]Professor, Regional Institute of Ophthalmology, Government Medical College, Amritsar, Punjab, India
saroj.sandhu[at]gmail.com

[3]Professor & Head, Regional Institute of Ophthalmology, Government Medical College, Amritsar, Punjab, India
karamjitsingh2010[at]gmail.com

[4]Associate Professor, Regional Institute of Ophthalmology, Government Medical College, Amritsar, Punjab, India
scorpiodoc9[at]gmail.com

[5]Assistant Professor, Regional Institute of Ophthalmology, Government Medical College, Amritsar, Punjab, India
manveen.kukreja[at]gmail.com

Corresponding Author:

Name: Dr. Gaurav Kumar
Address: Mohalla Plahi Gate, Opposite Ambedkar Park, Phagwara-144401, Punjab, India
Email Id: ggaurav29[at]gmail.com

Running Title: Study to evaluate Changes in Central Macular Thickness Following Uncomplicated Small Incision Cataract Surgery in Diabetic and Non-Diabetic Patients

Abstract: ***Introduction: Cataract surgery is a widely performed ophthalmological procedure. However, systemic conditions like diabetes mellitus may alter postoperative outcomes such as macular thickness and visual acuity. This study aimed to compare changes in central macular thickness (CMT) and best-corrected visual acuity (BCVA) after uncomplicated small incision cataract surgery (SICS) in diabetic and non-diabetic patients. Materials and Methods: A prospective, comparative study was conducted at the Regional Institute of Ophthalmology, Government Medical College, Amritsar, between 2023 and 2024. A total of 200 patients (100 diabetics and 100 non-diabetics) undergoing uncomplicated SICS with posterior chamber intraocular lens (PCIOL) implantation were enrolled. Patients with pre-existing macular pathology, uveitis, or intraoperative complications were excluded. Detailed ophthalmic examinations including BCVA, slit-lamp evaluation, fundus examination, intraocular pressure measurement, and central macular thickness (CMT) using optical coherence tomography (OCT) were performed preoperatively and postoperatively at 1, 6, and 12 months. Statistical analysis was performed using SPSS v23.0 with appropriate parametric and non-parametric tests. Results: In non-diabetic patients, mean preoperative CMT was 228.78 ± 2.09 µm, increasing to 252.65 ± 2.53 µm at one month, then reducing to 231.83 ± 3.69 µm at one year. In diabetic patients, CMT increased from 232.24 ± 11.02 µm to 275.23 ± 4.52 µm at one month and remained higher (243.64 ± 8.79 µm) at one year. BCVA improved in both groups but more significantly in non-diabetics (52% achieving 6/6 vs 36% in diabetics at 12 months). Conclusion: Both diabetic and non-diabetic patients showed improvement in BCVA and transient increase in macular thickness after SICS. However, diabetic patients had a more pronounced and prolonged CMT elevation and less complete visual recovery.***

Keywords: Macular thickness, Visual acuity, small incision cataract surgery, Diabetes, OCT

1.Introduction

Cataract is defined as an opacification or loss of transparency of the crystalline lens, which leads to reduced visual acuity and is a leading cause of treatable blindness worldwide. While age-related cataract is the most frequent form, systemic conditions such as diabetes mellitus leads to increase in the risk of early cataract development significantly. In diabetic patients, chronic hyperglycemia induces osmotic and oxidative stress within the lens, accelerating opacification. Patients with diabetes present with earlier onset, faster progression, and distinct morphological types of cataract.[1]

Despite the advancements in surgical techniques, patients with diabetes are more susceptible to postoperative ocular complications, including macular edema. which is the accumulation of extracellular fluid in the central retina.[2] Post-surgical cystoid macular edema (CME) is a well-recognized complication that can significantly impair vision, with reported incidences ranging from 0.1% to 2.35% following modern cataract extraction surgery.[3] The pathogenesis of postsurgical CME is multifactorial, but inflammatory

processes and increased levels of intraocular prostaglandins and other mediators released during surgical trauma are considered major contributors. These mediators disrupt the blood-retinal barrier, leading to fluid leakage and perifoveal intraretinal fluid accumulation.[4]

Diabetic patients are at a particularly high risk of developing postoperative CME, especially those with pre-existing diabetic retinopathy (DR). DR, a microvascular complication of diabetes, results from prolonged poor glycemic control, damaging retinal vasculature and leading to fluid leakage and potential vision loss. The severity of pre-existing DR correlates with a higher risk of postoperative CME. Even without clinically evident DR, diabetic individuals face an increased risk of macular edema following surgery. Identifying these risk factors is crucial for prevention and effective management.[5]

Optical Coherence Tomography (OCT) has emerged as the gold standard for diagnosing CME due to its non-invasive, high-resolution imaging capabilities, allowing for the detection of subtle changes in retinal thickness not visible clinically. OCT reveals macular thickening and cystic spaces, predominantly in the inner nuclear and outer plexiform layers, indicative of fluid accumulation.[6]

The aim of this study was to determine and compare changes in macular thickness and best-corrected visual acuity following uncomplicated SICS in diabetic patients (with or without diabetic retinopathy) and non-diabetic patients, and to elucidate the optical tomographic features of macular thickness changes.

2.Materials and Methods

This prospective comparative study was conducted at the Ophthalmology Department of Government Medical College, Amritsar, over a one-year period from, after obtaining permission from the Thesis committee and Institutional Ethics Committee. A total of 200 patients undergoing small incision cataract surgery (SICS) were randomly selected, comprising 100 non-diabetic patients (Group A) and 100 diabetic patients (Group B, including those with mild to moderate non-proliferative diabetic retinopathy (NPDR)). Written informed consent was obtained from all participants, who had the right to withdraw from the study at any time.

Inclusion Criteria:

- Patients with type 2 diabetes mellitus diagnosed with immature
- Non-diabetic patients diagnosed with immature cataract.
- Diabetic and non-diabetic patients willing to comply with study requirements.

Exclusion Criteria:

- Patients with additional underlying ocular diseases other than diabetes and cataract that could affect macular thickness (e.g., uveitis, glaucoma, epiretinal membrane, ocular hypertension).
- Patients with proliferative diabetic retinopathy (PDR) or severe non-proliferative diabetic retinopathy.
- Patients with pre-existing macular edema or any other macular pathology, retinal, or choroidal disease.
- Patients with a history of previous ocular surgery or retinal laser procedures.
- Patients with media opacities other than cataract.
- Patients with instability of zonular fibers preoperatively or intraoperatively.
- Patients experiencing intraoperative complications such as vitreous loss or posterior capsule rupture.
- Patients with central foveal point thickness greater than 250 µm on preoperative OCT assessment.

Evaluation Protocol:

A detailed history was taken, including age, sex, eye undergoing operation, type of diabetic therapy (insulin or oral), presence of renal or heart disease, hypertension, history of preoperative laser or other eye surgery, cataract surgery duration, viral markers, and operative complications. Fasting serum glucose levels and blood pressure were also recorded.

Ocular examination included:

Recording of preoperative distance visual acuity and best-corrected visual acuity (BCVA) using Snellens chart. Intraocular pressure (IOP) measurement using Applanation tonometry. Anterior segment examination with a slit lamp. Fundus examination by indirect ophthalmoscope and slit lamp biomicroscopy with a 90D lens after pupil dilation. Optical Coherence Tomography (OCT) of each eye was performed in dilated pupils to assess macular status, specifically measuring foveal, inner macular, outer macular thickness, macular volume, and pattern of cystoid macular edema.

Follow-up: All enrolled patients were followed up for one year after SICS. Follow-up examinations were conducted at 1 month, 6 months, and 12 months post-surgery to evaluate and document best-corrected postoperative visual acuity, central macular thickness (CMT), and intraocular pressure (IOP). SD-OCT was used for all macular characteristic measurements.

Statistical Analysis: The collected data, including OCT parameters and BCVA, were analyzed using appropriate statistical methods. SPSS software was utilized for statistical analysis. The difference in mean CMT and visual outcomes between diabetic and non-diabetic patients was compared using Student's 't' test or Mann-Whitney test. Pearson's chi-square test was employed to determine statistically significant differences between expected and observed frequencies in categories. A p-value of <0.05 was considered statistically significant.

3.Results

Table 1: Demographic, Clinical, and Visual Acuity Characteristics of Study Participants

Characteristic	Group A (Non-Diabetic)	Group B (Diabetic)
Age (Years)		
Mean ± SD	58.57 ± 6.76	60.21 ± 7.57
51–60 Years	61%	49%
61–70 Years	22%	33%
Gender		
Male	42%	48%
Female	58%	52%
Random Blood Sugar (RBS, mg/dL)		
Preoperative	117.26 ± 14.86	144.57 ± 30.33
1 Month Post-op	122.63 ± 13.77	144.34 ± 29.75
6 Months Post-op	129.66 ± 12.83	147.02 ± 29.23
1 Year Post-op	130.1 ± 12.21	146.68 ± 30.54
Preoperative BCVA		
6/9	1%	0%
6/18	35%	40%
6/24	48%	30%
6/36	12%	10%
Postoperative BCVA at 1 Month		
6/6	48%	31%
6/9	49%	41%
6/36	1%	16%
6/60	1%	6%
Postoperative BCVA at 6 Months		
6/6	52%	36%
6/9	45%	35–36%
6/12	3%	13%
6/18	0%	13%
Postoperative BCVA at 1 Year		
6/6	52%	36%
6/9	45%	35–36%
6/12	3%	26%

This table summarizes the baseline characteristics and visual acuity outcomes for both non-diabetic (Group A) and diabetic (Group B) patients included in the study. It provides insights into the age and gender distribution of the participant groups, as well as their random blood sugar levels, highlighting the metabolic differences between the two cohorts. Furthermore, it presents a comparison of best-corrected visual acuity (BCVA) at preoperative and various postoperative time points, illustrating the visual improvement in both groups following cataract surgery.

Best-Corrected Visual Acuity (BCVA):

- Group A: Postoperative improvement was rapid and consistent with 52% achieving 6/6 vision by 12 months.
- Group B: Only 36% achieved 6/6 vision at 12 months. A significant proportion retained suboptimal vision (e.g., 6/12 in 26% of patients).

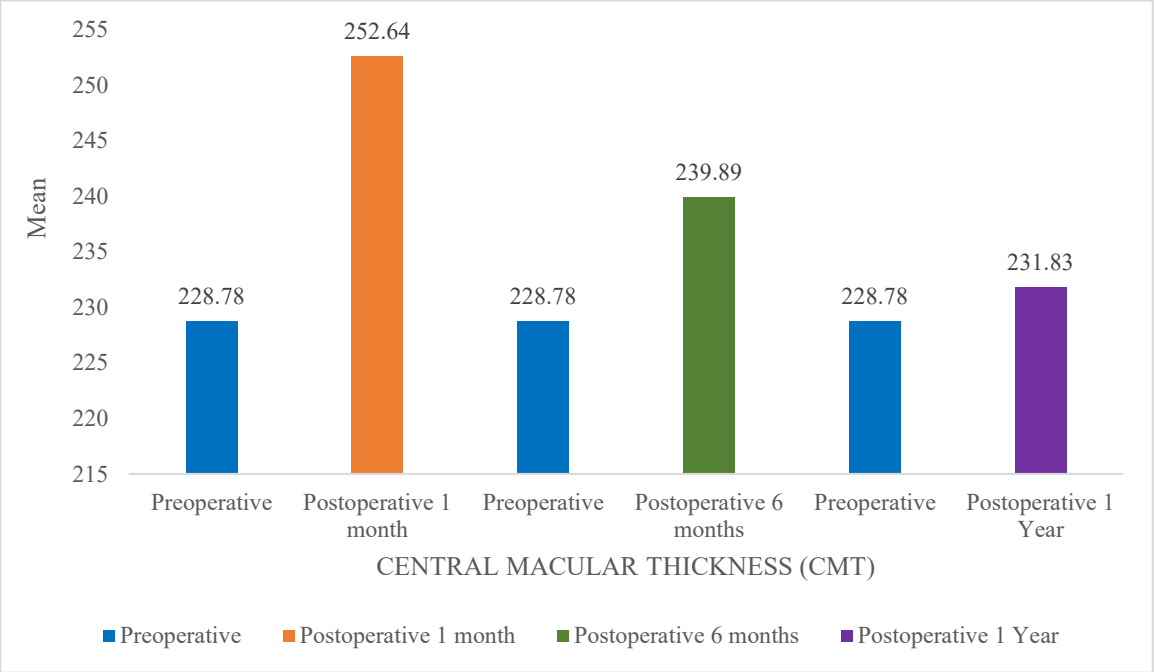
Table 2: Central Macular Thickness (CMT) Changes Before and After Cataract Surgery

Time Point	Group A (Non-Diabetic, Mean CMT ± SD µm)	Group B (Diabetic, Mean CMT ± SD µm)
Preoperative	228.78 ± 2.09	232.24 ± 11.02
1 Month Postoperative	252.65 ± 2.53	275.22 ± 4.52
6 Months Postoperative	239.89 ± 2.34	252.23 ± 7.82
1 Year Postoperative	231.83 ± 3.69	242.01 ± 11.43

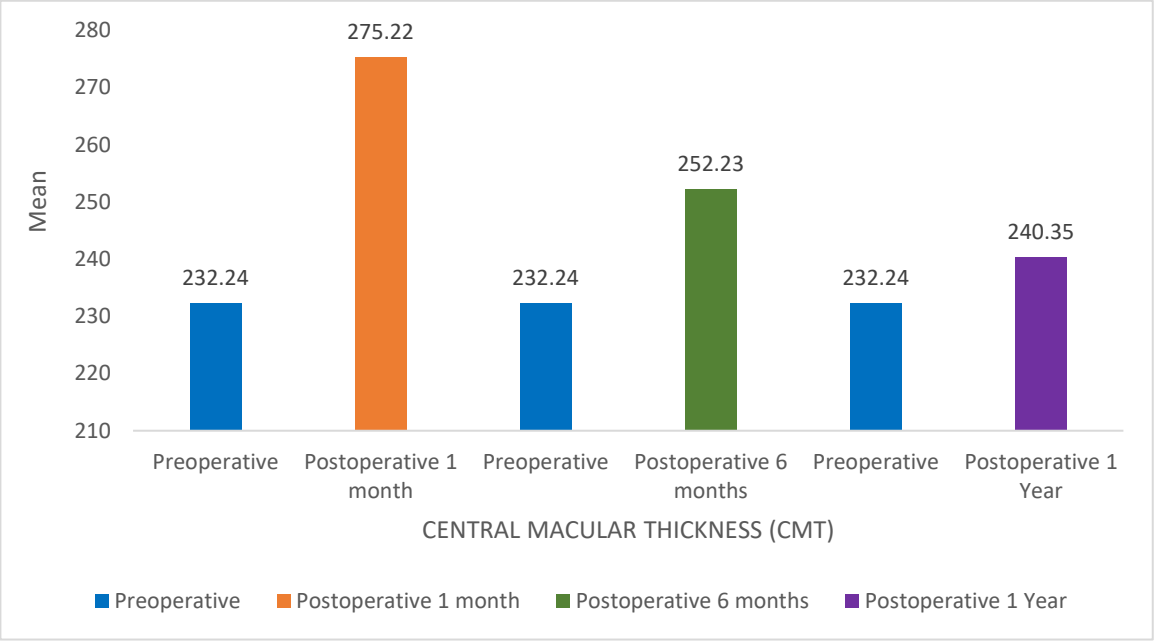
This table details the changes in central macular thickness (CMT) as measured by Optical Coherence Tomography (OCT) in both non-diabetic and diabetic patients over the study period. It provides a comparative view of mean CMT values at preoperative and various postoperative intervals, highlighting the differential macular responses to cataract surgery between the two groups. The data presented here underlines the transient increase in CMT observed in both cohorts and the more pronounced and prolonged elevation seen in diabetic patients.

CMT remained consistently higher in diabetics at all intervals, indicating a more prolonged macular response.

Mean Central Macular Thickness (CMT) Preoperative and Postoperatively (1 Months, 6 Months And 1 Year) in group A



Mean Central Macular Thickness (CMT) Preoperative and Postoperatively (1 Months, 6 Months And 1 Year) in Group B



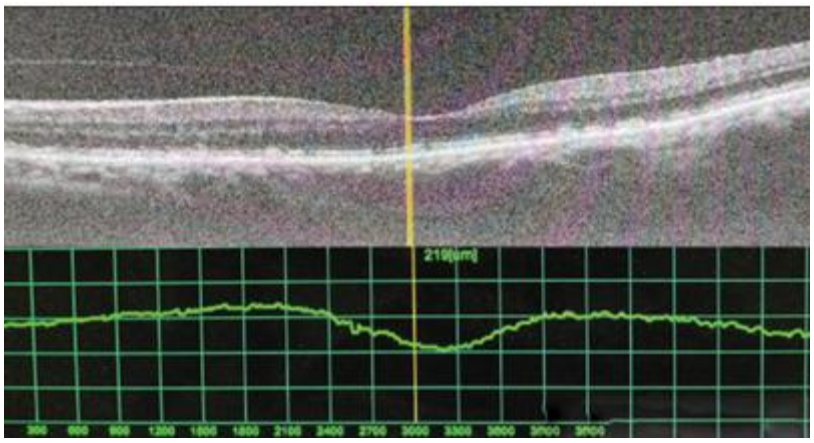


Figure 1: Showing preoperative CMT (Central Macular Thickness)

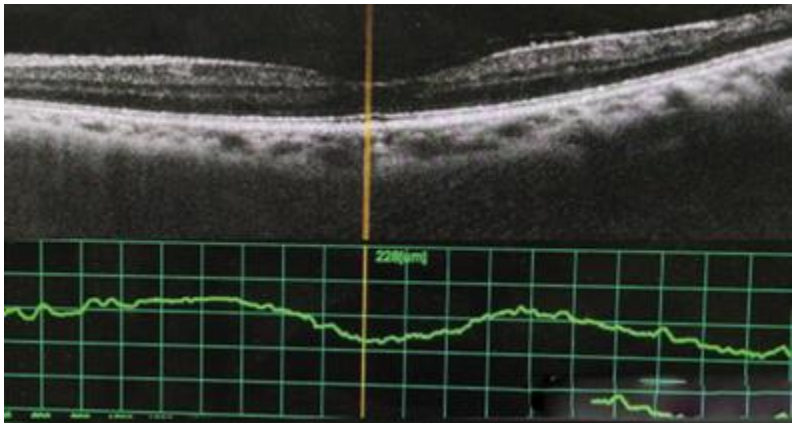


Figure 2: Showing post-operative CMT (Central Macular Thickness)

4.Discussion

Our findings reaffirm the significant impact of diabetes on postoperative recovery after cataract surgery. Although both diabetic and non-diabetic patients benefit visually, diabetics demonstrate prolonged macular thickening likely due to sustained subclinical inflammation and blood-retinal barrier disruption.

In the present study, the majority of participants in both diabetic and non-diabetic groups were within the 51–60 year age range, ensuring demographic uniformity and minimizing potential confounding effects of age on surgical outcomes. The mean age in the diabetic group was slightly higher (60.21 ± 7.57 years) compared to the non-diabetic group (58.57 ± 6.76 years), enhancing the reliability of intergroup comparisons. Comparable findings were reported by Stunf Pukl S et al.[7], who noted a mean age of 71.1 ± 6.9 years in cataract surgery patients, with diabetics averaging 73.5 ± 7.01 years and non-diabetics 68.8 ± 4.70 years, indicating balanced age distributions. Similarly, Dabas G et al. (2022) [8] observed a wide age range (40–98 years), with a mean of 61.85 ± 11.41 years and a modest female predominance.

In the current study, gender distribution was relatively balanced across both groups. Group A included 42% males and 58% females, while Group B comprised 48% males and 52% females. This slight female predominance ensures minimal gender-based bias in evaluating outcomes. These findings align with those of Dabas G et al. (2022)[8], who reported 59.17% female and 40.83% male participants, with an evenly distributed laterality of surgeries—51.67% right eyes and 48.33% left eyes. Conversely, Singh S et al. (2024) [9] noted a male predominance (60%) in their SICS cohort. Despite such variations, the overall gender balance in our study supports the validity of comparing surgical outcomes and suggests that gender did not significantly influence postoperative macular changes or visual recovery.

Our study observed a postoperative rise in central macular thickness (CMT) in both diabetic and non-diabetic groups, though the magnitude and persistence of this change were more prominent in diabetic patients. Non-diabetic individuals (Group A) showed a transient increase in CMT, peaking at one month and returning near baseline by one year, consistent with a typical, self-limiting inflammatory response. In contrast, diabetic patients with mild to moderate NPDR (Group B) exhibited a more pronounced and prolonged elevation in CMT that persisted even after one year, likely due to underlying microvascular changes.

These trends align with prior research. Stunf Pukl S et al. (2017) and Kwon SI et al. (2011) [10] also reported significant postoperative macular thickening in diabetics, often accompanied by a higher incidence of macular edema, particularly within the first postoperative month. Gharbia M et al. (2013) [11] found that while central macular thickening may normalize by six months, outer retinal regions can remain persistently thickened. Dabas G et al. (2022) further noted a modest, self-limiting CMT increase in the general population, which resolved by 12 weeks. Similar patterns were described by Bhargava et al. and Salwan A et al. [12], supporting the reproducibility of these postoperative changes.

Visual acuity improved significantly across both groups postoperatively, with superior and more consistent visual outcomes in non-diabetic individuals. In Group A, 48% of patients achieved 6/6 vision at one month, rising to 52% at one year. Group B lagged slightly, with 31% achieving 6/6 at one month and 36% at one year. These findings correlate with studies by Dabas et al. [8] and Singh S et al. [9], which showed delayed visual rehabilitation in diabetic patients, likely due to persistent retinal alterations. These results highlight the importance of individualized follow-up and proactive management in diabetic patients to ensure optimal postoperative recovery. [13]

5.Conclusions

Our study concludes that while small-incision cataract surgery (SICS) significantly improves visual outcomes and causes a transient increase in central macular thickness (CMT) in both diabetic and non-diabetic patients, the extent and pace of recovery differ notably between the two groups. Non-diabetic patients showed quicker resolution of postoperative macular changes and achieved more consistent and superior visual acuity outcomes over time. In contrast, diabetic patients—particularly those with mild to moderate NPDR—exhibited a more pronounced and prolonged increase in CMT, along with relatively slower and less complete visual recovery, probably due to underlying microvascular and retinal alterations. These findings

highlight the importance of preoperative diabetic control and close postoperative monitoring in patients having diabetes who underwent cataract surgery to optimize visual rehabilitation and manage complications effectively.

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