RESEARCH ARTICLE

# Corneal oedema post phacoemulsification surgery: A comparison between type 2 diabetic and non-diabetic patients

Bisma Qasim[1], Nisar Ahmed Siyal[2], Maria Saleem[3], Muhammad Adnan[4], Muhammad Nizamuddin[5]

## Abstract

**Objective:** To determine the association of post-phacoemulsification surgery corneal oedema between type 2 diabetic and non-diabetic patients in a tertiary care setting.

**Method:** The prospective cohort study was conducted from November 2024 to February 2025 at the Ophthalmology Department of Dow University Hospital, Karachi, and comprised patients of either gender undergoing phacoemulsification. The patients were stratified into study group A comprising type 2 diabetics and the non-diabetic control group B. Standardised phacoemulsification was performed and postoperative evaluations were conducted on days 1, 7 and 30. Corneal oedema incidence and severity were compared between the groups. Data was analysed using SPSS 26.

**Results:** Of the 100 patients, 50(50%) were in group A; 28(56%) females and 22(44%) males with mean age 60.3±5.98 years. There were 50(50%) patients in group B; 34(68%) females and 16(32%) males with mean age 60.1±6.17 years ($p$>0.05). On postoperative day 1, corneal oedema was observed in 36(72%) patients in group A compared to 18(36%) in group B ($p$<0.001). Group A patients had a significantly higher incidence of severe corneal oedema on day 1 (p=0.003) and day 7 ($p$=0.009), with a 7.6-fold increased likelihood compared to non-diabetics (odds ratio: 7.6; 95% confidence interval: 1.8-30; $p$<0.01). In group A, oedema was more frequent in uncontrolled diabetics having glycated haemoglobin >7% ($p$<0.05). Uncorrected visual acuity (6/6-6/12) on postoperative day 1 was achieved in 16(32%) group A patients compared to 26(52%) in group B. By day 30, 62(62%) of all the patients achieved uncorrected visual acuity of 6/6.

**Conclusion:** The likelihood of post-phacoemulsification corneal oedema was greatly increased by type II diabetes, particularly when it was poorly controlled, and it also slowed vision recovery.

**Keywords:** Diabetes mellitus, Type II phacoemulsification, Corneal oedema, Glycated haemoglobin, Prospective studies, Treatment outcome. (JPMA 75: 1752; 2025) **DOI: https://doi.org/10.47391/JPMA.30812**

## Introduction

Cataract is one of the most prevalent causes of vision loss worldwide.[1] According to the World Health Organization (WHO), 2.2 billion people worldwide have near or distance vision impairment, of which 1 billion cases are preventable. Cataract alone contributes to 94 million cases of blindness or visual impairment.[2] In Pakistan, cataracts account for 51.5% of preventable blindness cases, with an estimation of 570,000 individuals (225,000 men and 345,000 women) suffering from cataract-related blindness.[3] Ultraviolet (UV) light exposure, diabetes mellitus (DM), hypertension (HTN), drug use and smoking are some of the modifiable risk factors for cataracts, with advancing age being the only significant risk factor.[4]

DM is becoming increasingly prevalent globally, impacting millions of people. The Global Burden of Disease Report states that the number of people with diabetes increased from about 333 million in 2005 to about 435 million in 2015.[5] The International Diabetes Federation (IDF) has estimated that there will be 853×10$^6$ diabetic patients by the year 2050.[6] In Pakistan, the age-standardised prevalence of DM is 31.4%.[6] It is reported that cataract has a five-fold increased risk of developing early in the life of diabetic patients than in non-diabetics, and it is the major cause of vision impairment in individuals with DM.[7]

Phacoemulsification (phaco) is now considered the surgery of choice for cataract removal, worldwide.[8] One of the most common complications following phaco is transient corneal oedema. Despite advancements in surgical procedures, 80% of cases of corneal problems following vitrectomy, pan retinal photocoagulation (PRP), cataract and refractive surgery occur in DM individuals.[9]

Corneal oedema may cause impaired visual acuity (VA) in the immediate postoperative period after phaco, which is concerning for both the surgeon and the patient. DM patients are more affected by phaco in terms of corneal endothelial damage. Furthermore, these patients experience a delayed recovery of corneal endothelial function and morphology.[10]

[1-4]Department of Ophthalmology and Visual Sciences, Dow International Medical College, Dow University of Health Sciences, Karachi, Pakistan; [5]Institute of Medical Technology, Dow University of Health Sciences, Karachi, Pakistan.

**Correspondence:** Bisma Qasim. e-mail: bisma.qasim95@gmail.com
ORCID ID: 0009-0002-3312-9006

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Despite the high prevalence of T2DM in Pakistan, there is limited research, to our knowledge, on the frequency of corneal oedema after phaco among type 2 DM (T2DM) patients. The current study was planned to fill the gap on literature by determining the association between post-phaco corneal oedema in T2DM and non-diabetic patients presenting at a tertiary care centre.

## Patients and Methods

The prospective cohort study was conducted at the Ophthalmology Department of Dow University Hospital, Karachi, from November 2024 to February 2025. After approval from the institutional ethics review board, the sample size was calculated using OpenEpi online calculator while taking the proportion of corneal oedema in T2DM patients as 75.8% and 4.8% in non-diabetic patients.[11] The power of the test was kept at 80%, confidence interval (CI) at 95% and relative risk at 15.9%. The calculated sample size was inflated by >550% for meaningful analysis. The sample was raised using non-probability consecutive sampling method. Those included were patients of either gender aged 55-80 years undergoing phaco procedure. The subjects had senile cataract that was classified using the Lens Opacities Classification System III (LOCS III),[12] specifically nuclear cataract (NO2-NO5), cortical cataract (C2-C5), or posterior sub-capsular cataract (P2-P5). Those excluded were patients with a history of uveitis, previous intraocular surgery, external ocular trauma, prior refractive surgery, or any systemic illness other than T2DM or HTN. Also excluded were patients with significant diabetic macular oedema, dense cataracts, corneal disease (particularly Fuchs' endothelial dystrophy), ocular HTN, glaucoma, or any intraoperative complications. Besides, patients with random blood glucose (RBG) level >200mg/dL prior to surgery were also excluded.

After taking informed consent from the participants, they were divided into study group A comprising T2DM patients, and the non-diabetic control group B. Group A patients had been diagnosed with T2DM for at least one year, and were receiving either oral antidiabetic medications or subcutaneous insulin therapy. Group B patients had no prior history of diabetes and their RBG level was <200mg/dL.

Each patient underwent detailed history-taking and initial screening, including uncorrected distance VA (UCVA) and best-corrected distance VA (BCDVA) using a Snellen's chart, intraocular pressure (IOP) measurement via Goldmann applanation tonometry, and anterior segment examination using slit-lamp biomicroscopy (SL-3C, Topcon Corporation, Tokyo, Japan). Dilated fundus examination was performed using a +90D lens. Blood pressure (BP), RBG and glycated haemoglobin (HbA1c) levels were recorded. Biometry was conducted using a keratometer (C.I.O.M. SRL Milano, Italy) and A-scan (Compact Touch, Quantel Medical, Cournon-d'Auvergne, France) to calculate axial length and determine the intraocular lens (IOL) power. All the individuals were instructed to instil moxifloxacin eye drops 4 times the day before their surgery. All the surgeries were carried out by a single, skilled surgeon with >3 years of expertise, keeping surgical parameters the same for an individual grade of cataract, using a standardised surgical technique that involved a clear corneal incision, injection of a viscoelastic agent, anterior capsulorhexis, hydro dissection, phaco (Visalis 100, Carl Zeiss Meditec AG, Goeschwitzer Strasse 51-52, 07745 Jena, Germany), irrigation and aspiration, viscoelastic in the bag, implantation of a foldable IOL into the bag, aspiration of viscoelastic, and hydration of the wound. Phaco power was set to 25% while phaco time was monitored in all cases. All patients had their dressing removed on the first postoperative day (POD) and the standard postoperative medication regimen was prescribed. All the patients were examined for assessment of outcome on the POD1 for UCDVA and with a pinhole (Snellen's chart), IOP measurement GAT-Goldmann applanation tonometry (Haag-Streit AG, Köniz, Switzerland), and corneal oedema were graded according to the Oxford cataract treatment and evaluation team (OCTET) on slit lamp examination as transient corneal oedema with no folds in the descemet membrane (+), transient corneal oedema with folds in the descemet membrane <10 (++), and transient corneal oedema with folds in the descemet membrane >10 (+++).[13] All the patients were followed as per the standard protocol on PID 7 and 30. Data was collected using a predesigned proforma.

Data was analysed using SPSS 26. Qualitative variables were reported as frequencies and percentages, while quantitative variables were expressed as mean±standard deviation or median with interquartile range (IQR), based on data distribution assessed using the Shapiro-Wilk test. Intergroup comparison of quantitative variables was done with Mann-Whitney U test. Effect modifiers, such as age, gender, and diabetes control, were addressed through stratification, and post-stratification analysis was performed using chi-square and Fisher exact tests, as applicable, along with the calculation of relative risk (RR) for outcome variables. P<0.05 was considered statistically significant.

## Results

Of the 100 patients, 50(50%) were in group A; 28(56%) females and 22(44%) males with mean age 60.3±5.98 years. There were 50(50%) patients in group B; 34(68%) females

and 16(32%) males with mean age 60.1± 6.17 years ($p$>0.05). The median age of groups A and B were 57 years (IQR: 55-64 years) and 59 years (IQR: 55-64 years), respectively ($p$=0.93).

The mean intraocular pressure (IOP) was 14±2.1mmHg in group B and 14±1.9mmHg in group A. The overall mean phaco time was 42.17±26.14 seconds; 43.34±21.01 seconds in group A and 41.00±30.60 seconds in group B ($p$=0.34). The overall median phaco time was 38 seconds (IQRL: 16-60 seconds) and the intergroup difference was not significant ($p$=0.23). Hypertension was present in 43(43%) patients; 15(30%) in group B and 28(56%) in group A ($p$=0.01) (Table 1).

**Table-1:** Baseline demographic characteristics.

| Demographic Characteristics | Overall | Control group (non-diabetics) | Study group (Diabetics) | *p*-value |
|---|---|---|---|---|
| Age (years) | | | | |
| Mean±SD | 60.2 ± 6.05 | 60.1 ± 6.17 | 60.3 ± 5.98 | |
| Median (IQR) | 58 (55 – 64) | 59 (55 – 64) | 57 (55-64) | 0.93* |
| IOP (mmHG) | | | | |
| Mean ± SD | 14 ± 3.5 | 14 ± 2.1 | 14 ± 1.9 | 0.7* |
| Phaco time (seconds) | | | | |
| Mean ± SD | 43 ± 35.2 | 42.17 ± 26.14 | 41 ± 30.6 | 0.5* |
| Median (IQR) | 38 (16-60) | 30 (15-60) | 41 (26 -55) | 0.23* |
| Hypertension | | | | |
| Yes | 43 (43%) | 15 (30%) | 28 (56%) | 0.01** |
| No | 57 (57%) | 35 (70%) | 22 (44%) | |
| Gender | | | | |
| Male | 38 (38%) | 16 (42.1%) | 22 (57.9%) | 0.2** |
| Female | 62 (62%) | 34 (54.8%) | 28 (45.2%) | |
| 1st postoperative day UCVA | | | | |
| 6/6-6/12 | 42 | 26 (52%) | 16 (32%) | 0.1** |
| 6/18-6/24 | 33 | 15 (30%) | 18 (36%) | |
| >6/30 | 25 | 9 (18%) | 16 (32%) | |
| 7th post-operative day end UCVA | | | | |
| 6/6-6/12 | 63 | 35 (70%) | 28 (56%) | 0.17** |
| 6/18-6/24 | 28 | 13 (26%) | 15 (30%) | |
| >6/30 | 9 | 2 (4%) | 7 (14%) | |

*Mann whitney U test; **Chi-Square; IOP: Intraocular pressure, UCVA: Uncorrected visual acuity.

**Table-2:** Incidence of corneal oedema on postoperative days 1 and 7.

| Group | 1st Postoperative day [n (%)] | | | | 7th Postoperative day [n (%)] | | | |
|---|---|---|---|---|---|---|---|---|
| | Corneal oedema | | Total | *p*-value | Corneal oedema | | Total | *p*-value |
| | Present | Absent | | | Present | Absent | | |
| **Control group** (non-diabetics) | 18 (36) | 32 (64) | 50 (100) | <0.001 | 4 (8) | 46 (92) | 50 (100) | <0.001 |
| **Study group** (Diabetics) | 36 (72) | 14 (28) | 50 (100) | | 18 (36) | 32 (64) | 50 (100) | |
| **Total** | 54 | 46 | 100 | | 22 | 78 | 100 | |
| **Chi-Square** | | | | | | | | |

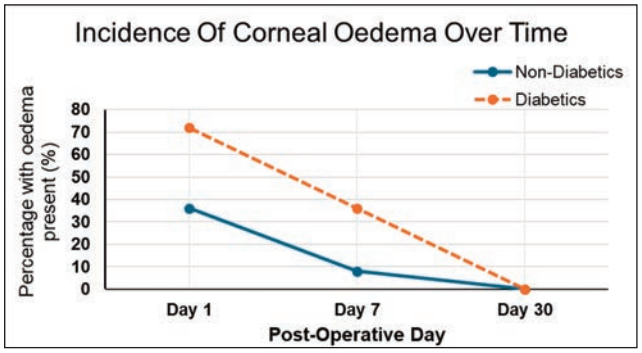


**Figure:** Incidence of corneal oedema from postoperative day 1 to 30.

**Table-3:** Grading of corneal oedema on postoperative days 1 and 7 [n (%)].

| Corneal Oedema | Control group (Non-diabetics) | | | Total | Study group (Diabetics) | | | Total |
|---|---|---|---|---|---|---|---|---|
| | + | ++ | +++ | | + | ++ | +++ | |
| **1st Postoperative day** | 2 (4) | 13 (26) | 3 (6) | 18 (36) | 5 (10) | 21 (42) | 10 (20) | 36 (72) |
| **7th Postoperative day** | 2 (4) | 1 (2) | 1 (2) | 4 (8) | 9 (18) | 3 (6) | 6 (12) | 18 (36) |

**Table-4:** Severe corneal oedema (+++) on postoperative day 1 [n (%)].

| | Severe corneal oedema (+++) | | Total | *p*-value | Odds Ratio (OR) (95% CI) |
|---|---|---|---|---|---|
| | Present | Absent | | | |
| **Diabetic** | 10 (20) | 40 (80) | 50 (100) | 0.037* | 3.92 (1.01–15.22) |
| **Non-Diabetic** | 3 (6) | 47 (94) | 50 (100) | | |
| **Total** | 13 | 87 | 100 | | |
| **Chi-Square*** | | | | | |

CI: Confidence interval.

**Table-5:** Incidence of corneal oedema on postoperative day 1 in controlled and uncontrolled diabetic patients [n (%)].

| Diabetic control | 1st Post operative day | | Total | *p*-value |
|---|---|---|---|---|
| | Yes | No | | |
| Controlled (HbA1c <7%) | 11 (55.0) | 9 (45.0) | 20 (100) | <0.05 |
| Uncontrolled (HbA1c >7%) | 25 (83.3) | 5 (16.7) | 30 (100) | |
| Total | 36 (72.0) | 14 (28.0) | 50 (100) | |

HbA1c: Glycated haemoglobin.

On POD1, 36(72%) group A patients exhibited corneal oedema compared to 18(36%) in group B ($p$<0.001). The RR for developing corneal oedema in group A in comparison to group B was 2.0 (95% CI: 0.86-4.66) (Table 2; Figure). Furthermore, on POD1, 10(20%) group A patients exhibited severe corneal oedema, which decreased to 6(12%) by POD7. In group B, the corresponding values were 3(6%) and 1(2%), respectively (Table 3). The difference in severe corneal oedema between the groups was significant on POD1 ($p$=0.037). When comparing the groups for developing severe corneal oedema, the odds ratio (OR) was 3.92 (95CI: 1.01-15.22; $p$<0.05), indicating that diabetic patients had a 3.92-fold higher likelihood of developing severe corneal oedema postoperatively (Table 4).

Within group A, 20(40%) individuals had controlled diabetes, while 30(60%) had uncontrolled diabetes (HbA1C >7%). Among the individuals with uncontrolled diabetes, 25(83.3%) had corneal oedema on POD1 compared to

11(55.0%) of those with controlled diabetes ($p$<0.05) (Table 5).

On the first postoperative day, UCDVA between 6/6 and 6/12 was achieved in 26(52%) group B patients and 16(32%) group A patients. By POD7, UCDVA of 6/6 to 6/12 was observed in 35(70%) group B patients and 28(56%) group A patients. By POD30, 62(62%) of the total patients achieved UCDVA 6/6, while the remaining 38(38%) had suboptimal vision attributed to refractive error, age-related macular degeneration, or amblyopia.

## Discussion

Modern cataract surgery has a high success rate with low complication rates. The WHO suggests that 80% of eyes undergoing cataract surgery should achieve a good visual outcome (presenting visual acuity 6/6–6/18), and at least 90% should achieve this level with best correction.[14] In the current study, 84% patients achieved final VA >6/12.

In the current study, the average age of diabetic patients was 60.3±5.98 years compared to 60.1±6.17 years in non-diabetic patients ($p$=0.2) the findings were consistent with literature.[15-17]

As expected, on POD1, 72% of diabetic patients exhibited corneal oedema compared to 36% of the non-diabetic patients, indicating that diabetic patients had a significantly higher incidence of corneal oedema in the immediate postoperative period compared to non-diabetic individuals. Similar findings from previous studies also indicate a higher incidence of corneal oedema in diabetic patients compared to non-diabetic patients.[12,18,19] However, Kauser A et al. and Sekelj S et al. concluded that on POD 1, corneal oedema was equally present in non-diabetic and T2DM patients.[20,21]

The current results demonstrated that severe corneal oedema was significantly more common in the diabetic group on both the first and seventh postoperative days. An OR of 3.92 suggested that diabetic patients had approximately 3.92 times higher likelihood of developing severe corneal oedema post-phaco compared to patients without diabetes. This aligns with the outcomes of a study by Tsaousis KT et al.,[18] which suggested that compared to non-diabetics, patients with diabetes had a roughly 3.5-fold higher likelihood of developing severe corneal oedema after phaco.

The persistence of corneal oedema in diabetic patients beyond the first postoperative week further highlighted the compromised corneal endothelial function in this population. On POD1, 72% of diabetic patients exhibited corneal oedema, with a significantly higher incidence in those with uncontrolled diabetes (83.3%) compared to those with controlled diabetes (55%) ($p$<0.05). This finding reinforced the importance of optimal glycaemic control in post-surgical corneal recovery.

VA outcomes were also affected by the presence of diabetes. The proportion of patients achieving UCDVA between 6/6 and 6/12 on POD1 was lower in the study group (32%) than the control group (52%). However, as corneal oedema resolved, VA improved by POD7 (70% in non-diabetics vs 56% in diabetics achieving UCVA of 6/6-6/12). By POD30, both groups demonstrated comparable visual recovery, indicating that while diabetes may have delayed visual rehabilitation, final visual outcomes remained similar in well-managed cases. Shakya K et al.[12] also found that on POD1, a higher proportion of non-diabetic patients achieved UCVA 6/6-6/12 compared to diabetic patients.

The current study has limitations. First, corneal oedema was clinically evaluated using slit lamp bio microscopy, which was a subjective assessment. However, a comprehensive slit lamp examination conducted in accordance with a standardised methodology ensured a satisfactory assessment of corneal oedema. Second, the endothelial cell count was not assessed in any of the eyes. However, homogeneity in endothelial cell reserves among individuals was assumed because extra care was taken to recruit patients with similar demographic parameters (age-matched) with no severe corneal diseases. Also, the median age did not differ significantly between the groups ($p$=0.93), which helped in eliminating age as a confounding factor in postoperative corneal response. Likewise, the IOP and phaco time were similar between the two groups, suggesting that surgical parameters were not significantly different and did not contribute to variations in corneal oedema.

## Conclusion

T2DM, particularly when poorly controlled, significantly increased the risk of post-phaco corneal oedema, and delayed visual recovery. Preoperative optimisation of glycaemic control and careful postoperative monitoring of corneal status are crucial to the task of improving surgical outcomes for diabetic patients undergoing phaco.

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**Author Contribution:**

**BQ:** Study design, methodology and drafting.
**NAS:** Provided clinical and surgical expertise, writing and reviewed the final draft.
**MS:** Data collection and performed calculations.
**MA:** Literature review and managed referencing.
**MN:** Data analysis and interpreted results.