Comparison of corneal endothelial changes following phacoemulsification in diabetic and non-diabetic patients

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Purpose: To study corneal endothelial changes post phacoemulsification in diabetic and non-diabetic patients. Methods: A comparative, prospective, observational study was conducted on 100 diabetic and 100 non-diabetics who underwent phacoemulsification. All patients were operated by the same surgeon by using the phaco chop technique to exclude any surgeon-related bias. Endothelial cell count, CCT, and coefficient of variance (CV) were measured with a specular microscope along with BCVA preoperatively and at 1 week, 4 weeks, and 3 months postoperatively. For statistical analysis, data were analyzed by using SPSS (version 27.0; SPSS Inc., Chicago, IL, USA). Data were summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Chi square test, independent sample T test, and paired T test were used to compare the data. P ≤ 0.05 was considered statistically significant. Results: Postoperatively at 1 week, 4-week, and 3 months follow-up intervals, the mean endothelial cell count and coefficient of variance were significantly higher, and the mean percentage of hexagonal cells was significantly lower in non-diabetic as compared to the diabetic group. A significant difference in mean central corneal thickness of the two groups was observed at 1-week and 4-weeks postoperative intervals; at both these intervals, the mean value was significantly higher in non diabetic as compared to the non-diabetic group. However, at 3-months post-operative interval, the difference between the two groups was not significant statistically. Mean BCVA values were significantly higher in diabetic as compared to the diabetic group at all three follow-up intervals. Conclusion: The findings of the present study show that endothelial cell characteristics are adversely affected in diabetic eyes as compared to non-diabetic patients undergoing phacoemulsification; this might also have an effect on the visual outcomes.

Key words: BCVA, central corneal thickness, corneal endothelium, diabetes, endothelial cell count, hexagonality, phacoemulsification

Cataract has been documented to be the number one cause of curable blindness globally\(^1\) and remains the leading cause of blindness in India (62.60%).\(^2\) Removal of the cloudy lens and implantation of a clear intraocular lens is the only definite treatment of cataract.\(^3\) Phacoemulsification with foldable intraocular lens implantation has become the gold standard treatment procedure for cataract management.\(^4,5\)

The hexagonal cells of the endothelium of cornea are responsible for maintaining the clarity of the cornea by actively removing water. These cells have limited mitotic capacity, and any disturbance in the endothelial homeostasis might have a profound effect on the clarity of the cornea.\(^6\)

The corneal endothelium is known to undergo damage during cataract surgery. Factors such as advanced age, increasing infusion volume, and increasing the amount of ultrasound energy and phaco time are the main risk factors for corneal endothelial damage.\(^7\)

Diabetes mellitus is a major health concern in our modern-day lives,\(^8\) affecting more than 415 million people worldwide (2015)\(^9\) and causing neuropathies, nephropathies, and CNS and eye complications. It can affect all structures of the eye, causing complications such as diabetic retinopathy, diabetic cataract, punctate epithelial keratopathy, recurrent corneal erosions, corneal edema, delayed wound healing, and persistent epithelial defects.\(^10,11\)

The diabetic cornea, which is more fragile and vulnerable to trauma, possesses a weaker compensatory capacity. The corneal endothelium of a patient with diabetes mellitus has been shown to exhibit polymegathism and pleomorphism.\(^12,13\) Although the cornea may appear disease free in the diabetics, an awareness of the marked biochemical and ultrastructural abnormalities in the diabetics can enable us to prevent more overt complications.\(^14\)

Increasing age decreases the endothelial cell count, and most of the patients undergoing cataract surgery are usually elderly, which may have a negative impact on the surgical outcome.\(^15\) This factor coupled with the effect of diabetes mellitus indicate
a great risk of long-term endothelium cell dysfunction with
decompensation and the development of bullous keratopathy.

The corneal endothelium is evaluated by central corneal
thickness (CCT), corneal endothelial cell density (ED), and
morphology pre and postoperatively. Specular microscopy
is a non-invasive and the most accurate photographic
technique that can be used to visualize and analyze the corneal
endothelium.

Studies that have been carried out so far on the importance
of corneal abnormalities commonly found in diabetic patients
after cataract surgery due to factors including the diabetic state.
Surgical procedures yield conflicting results concerning
the differences in corneal properties between diabetic and
non-diabetic patients after phacoemulsification.

Thus, this study was carried out to assess the vulnerability
of the corneal endothelium in diabetics and non-diabetics
undergoing phacoemulsification to avoid postoperative corneal
edema and improve the final visual outcome.

**Methods**

A 1-year comparative, prospective, observational study was
conducted in the ophthalmology outpatient department in
accordance with the tenets of the Declaration of Helsinki and
was cleared by the institute’s ethical committee.

The patients were divided into two groups: Diabetic:
Patients diagnosed with type two diabetes mellitus with
good glycemic control (HbA₁c < 7) and senile cataract. Serum
glycosylated hemoglobin levels were obtained in all patients
with diabetes to evaluate glycemic control. Non-diabetic:
Age-matched patients without diabetes with senile cataract.
Two random blood glucose tests were taken in accordance
with recommendations of the American Diabetic Association
to detect undiagnosed diabetes.

Patients in the age group of 40–60 years, willing to give
informed consent for surgery and study and come for
follow-up, with cataract grade of nuclear sclerotic cataract
I to III, and with no history of previous ocular surgery were
included in the study. Patients with a preoperative endothelial
cell count of >1500 cells/mm² and an anterior chamber depth
of >2.5 mm were included in the study. Patients with traumatic
cataract, any corneal pathology (e.g., Fuch’s dystrophy),
pseudoexfoliation, history of ocular trauma or intraocular
surgery, intraocular inflammation or any other ocular disease
that may affect endothelial cell function (such as glaucoma,
uveitis, patients with diabetic retinopathy or any other retinal
pathology) were excluded from the study.

History of any eye disease, DM type and complications,
onset age and duration, and blood glucose control method were
recorded. All of the participants underwent a comprehensive
eye examination. Visual acuity (VA) was recorded in both the
eyes. Keratometry, A-scan, Hba1c levels in diabetic patients,
and two random blood glucose levels in non-diabetic patients
were recorded. Preoperative specular microscopy (Tomey, EM–
1000, Japan) for evaluation of ED, coefficient of variation (CoV),
CCT, and percentage of cell hexagonality (%Hex) was done. All
patients were operated by a single well-experienced surgeon by
using the same phacoemulsification equipment under topical
anesthesia. The follow-up regimen was followed after 1 week,
1 month, and 3 months after cataract surgery. BCVA, slit-lamp
examination, and specular evaluation of the endothelium was
done on each follow-up.

The samples were calculated by assuming 80% power,
5% significance level with 95% confidence interval as well as
absolute error being 44 and assumed standard deviation being
150. The total sample size calculated was 100 per group.

For statistical analysis, data were entered into a
Microsoft Excel spreadsheet and then analyzed by using
SPSS (version 27.0; SPSS Inc., Chicago, IL, USA). Data were
summarized as mean and standard deviation for numerical
variables and count and percentages for categorical variables.

Chi-square test, independent sample T test, and paired T
were used to compare the data. $P \leq 0.05$ was considered
statistically significant.

**Results**

The present study was carried out to compare the corneal
endothelial changes after phacoemulsification in diabetic and
non-diabetic patients. For this purpose, a prospective,
comparative, observational study was carried out that included
a total of 200 patients scheduled to undergo phacoemulsification.
Table 1 shows the group-wise distribution of cases, and Table 2
shows the diabetic profile of patients in the diabetic group.

Out of the total of 200 subjects enrolled in the study, a total
of 100 subjects were diabetics with good glycemic control (HbA₁c < 7),
whereas the remaining 100 were age-matched non-diabetics with
senile cataract. The difference between the mean pre-op BCVA,
IOP, and RBS values in non-diabetic and diabetic subjects was not
significant for mean BCVA and IOP values ($P > 0.05$); however,
mean RBS was significantly higher in diabetic as compared to the
non-diabetic group ($P < 0.001$). The average cumulated dissipated
phaco energy was statistically insignificant.

Statistically, there was no significant difference
between mean ED in non-diabetic and diabetic groups
preoperatively ($P = 0.091$). Postoperatively, mean values were
higher in non-diabetic as compared to the diabetic group,
and the difference between the two groups was significant
statistically ($P < 0.001$) [Table 3]. With respect to intragroup
comparisons, in both groups, the change from baseline
was significant at all time intervals ($P < 0.001$). It was seen that the
mean decline showed a gradual increase at each follow-up with
maximum change observed at 3 months [Table 4].

Preoperatively, there was no significant difference in CoV
between diabetics and non-diabetics ($P = 0.129$). Postoperatively,
the mean CoV values were lower in non-diabetic as compared to
the diabetic group, and the difference between the two
groups was significant statistically at 1-week and 4-weeks
post-operative intervals ($P < 0.001$). Values were higher in
the diabetic group as compared to the non-diabetic group at
3-months too, but the difference was not found to be significant
statistically ($P = 0.066$) [Table 3]. With respect to intragroup
changes, in both the diabetic and non-diabetic groups, at all
the time intervals, the change from baseline was significant
statistically ($P < 0.001$). In both the groups, the peak change was
at 4-week while the minimum change was at 3-months [Table 4].

Preoperatively, there was no significant difference in
mean percentage hexagonal cell values between the two
### Table 1: Comparison of the demographic profiles and baseline characteristics of the study population

| Characteristic | Non-diabetic (n=100) | Diabetic (n=100) | Statistical significance, P |
|---------------|----------------------|-----------------|----------------------------|
| Mean age±SD (Range) in years | 57.94±6.65 (43-70) | 58.52±6.29 (45-69) | 0.527 |
| Gender | | | |
| Male | 54 | 54 | 1.000 |
| Female | 46 | 46 | 1.000 |
| Side involved | | | |
| Left | 46 | 39 | 0.317 |
| Right | 54 | 61 | 0.317 |
| Cataract grade | | | |
| I | 14 | 14 | 0.311 |
| II | 51 | 41 | 0.311 |
| III | 35 | 45 | 0.311 |
| Mean BCVA±SD (LogMAR) | 0.67±0.20 | 0.69±0.21 | 0.519 |
| Mean IOP±SD (mm Hg) | 13.51±2.41 | 13.47±2.68 | 0.912 |
| Mean RBS±SD (mg/dl) | 122.74±11.34 | 131.18±17.75 | <0.001 |

### Table 2: Diabetic profile of patients in the diabetic group

| Characteristic | Statistic |
|---------------|-----------|
| Mean duration of diabetes±SD (Range) in years | 3.06±1.54 (1-8) |
| Mean HbA₁c±SD (Range) in % | 6.12±0.38 (5.40-6.90) |

between the two groups was found to be significant at all three follow-up intervals (P < 0.05) [Table 5].

Pearson correlation studies to find the relationship between the energy used during phacoemulsification and the various endothelial parameters did not show a significant correlation in diabetics and non-diabetic groups.

### Discussion

In the present study, as compared to baseline, the mean changes in the endothelial cell density at first, second, and third follow-up intervals in the non-diabetic patients were significant statistically. In the corresponding time intervals, there was a mean change in the endothelial cell density at first, second, and third follow-up intervals in the diabetic group with a significant change from baseline from the first follow-up itself. It was seen that at all the follow-up intervals, the mean endothelial cell density in diabetic cases was significantly lower as compared to non-diabetic patients. In effect, the findings of the study showed that while cases experienced a marginal loss in endothelial cell density in non-diabetic population, the diabetic population showed a relatively much higher endothelial cell density loss.

Compared to the present study, Fernández-Muñoz(22) did not find a significant difference in the mean endothelial cell count between diabetic and non-diabetic patients. Contrary to these findings, in the present study, we found the mean count to be significantly lower in diabetic as compared to non-diabetic patients at all three follow-up intervals. The results in present study are somewhat close to the observations made by Al-Sharkawy et al.(24) who observed a % endothelial cell loss of 5.4% and 8.1%, respectively, at 1 month and 3-month follow-up intervals in diabetic patients and 6.5% and 8.4%, respectively, in the non-diabetic group. In a meta-analysis of 13 studies, Tang et al.(14) reported that diabetic patients tend to have a lower cell density as compared to non-diabetic patients; however, the extent of this difference is highly variable too.

In the present study, the mean CoV was higher in diabetic patients as compared to non-diabetic patients at all three follow-up intervals and the difference was significant statistically at 1-week and 4-weeks follow-up. In both groups, the change from baseline was significant statistically at all three
Table 3: Summary of corneal endothelial parameters preoperative and 1 week, 1 month, and 3-month post-op

| Corneal parameters | Time interval | Group          | Mean       | SD          | Minimum   | Maximum   | P       |
|-------------------|--------------|----------------|------------|-------------|-----------|-----------|---------|
| ECD               | Pre-op.      | Non-diabetic   | 2475.15    | 181.61      | 2116      | 3271      | 0.091   |
|                   |              | Diabetic       | 2430.93    | 186.56      | 2100      | 2967      |         |
|                   | 1-week post-op. | Non-diabetic   | 2403.22    | 190.72      | 1921      | 3068      | <0.001  |
|                   |              | Diabetic       | 2267.50    | 168.24      | 1982      | 2774      |         |
|                   | 4-weeks post-op. | Non-diabetic   | 2371.55    | 193.18      | 1926      | 3042      | <0.001  |
|                   |              | Diabetic       | 2213.84    | 177.00      | 1923      | 2768      |         |
|                   | 3-months post-op. | Non-diabetic   | 2323.95    | 195.00      | 1895      | 2989      | <0.001  |
|                   |              | Diabetic       | 2139.88    | 190.70      | 1734      | 2697      |         |
| CoV               | Pre-op.      | Non-diabetic   | 33.05      | 2.71        | 26        | 39        | 0.129   |
|                   |              | Diabetic       | 33.68      | 3.11        | 26        | 39        |         |
|                   | 1-week post-op. | Non-diabetic   | 37.76      | 3.23        | 30        | 43        | <0.001  |
|                   |              | Diabetic       | 38.99      | 3.24        | 32        | 46        |         |
|                   | 4-weeks post-op. | Non-diabetic   | 38.14      | 3.58        | 30        | 43        | <0.001  |
|                   |              | Diabetic       | 40.25      | 3.26        | 32        | 48        |         |
|                   | 3-months post-op. | Non-diabetic   | 35.13      | 4.73        | 25        | 46        | <0.001  |
|                   |              | Diabetic       | 36.23      | 3.61        | 28        | 44        |         |
| % Hexagonal Cells | Pre-op.      | Non-diabetic   | 73.90      | 3.24        | 66.00     | 80.00     | 0.274   |
|                   |              | Diabetic       | 73.32      | 4.18        | 63.00     | 80.00     |         |
|                   | 1-week post-op. | Non-diabetic   | 68.92      | 3.64        | 61.00     | 77.00     | <0.001  |
|                   |              | Diabetic       | 63.87      | 4.05        | 54.00     | 76.00     |         |
|                   | 4-weeks post-op. | Non-diabetic   | 70.60      | 3.94        | 61.00     | 81.00     | <0.001  |
|                   |              | Diabetic       | 66.28      | 4.08        | 57.00     | 78.00     |         |
|                   | 3-months post-op. | Non-diabetic   | 72.49      | 4.08        | 62.00     | 85.00     | <0.001  |
|                   |              | Diabetic       | 68.30      | 4.24        | 59.00     | 81.00     |         |
| CCT               | Pre-op.      | Non-diabetic   | 518.29     | 15.82       | 483       | 576       | 0.330   |
|                   |              | Diabetic       | 520.46     | 15.59       | 469       | 554       |         |
|                   | 1-week post-op. | Non-diabetic   | 527.73     | 13.40       | 495       | 564       | <0.001  |
|                   |              | Diabetic       | 536.25     | 16.72       | 492       | 579       |         |
|                   | 4-weeks post-op. | Non-diabetic   | 523.85     | 13.90       | 491       | 570       | 0.003   |
|                   |              | Diabetic       | 530.20     | 15.67       | 479       | 567       |         |
|                   | 3-months post-op. | Non-diabetic   | 522.42     | 12.70       | 490       | 557       | 0.745   |
|                   |              | Diabetic       | 523.71     | 17.70       | 466       | 560       |         |

Table 4: Evaluation of intragroup change in cell-density, CoV, CCT, and hexagonality at different follow-up intervals as compared to baseline

| Corneal Parameters | Comparison               | Non-diabetic Group | Diabetic group |
|-------------------|--------------------------|--------------------|---------------|
|                   | Change from baseline     | Mean   | SD   | %    | P (Paired t-test) | Mean   | SD   | %    | P (Paired t-test) |
|                   | Change in               |        |      |     |                |        |      |     |                |
|                   | Endothelial cell density| Baseline vs. 1-week | -71.93  | 180.89 | -2.91 | <0.001 | -163.43 | 71.61 | -6.72 | <0.001 |
|                   | Baseline vs. 4-weeks     | -103.60 | 184.45 | -4.19 | <0.001 | -217.09 | 84.37 | -8.93 | <0.001 |
|                   | Baseline vs. 3-months    | -151.20 | 178.41 | -6.11 | <0.001 | -291.05 | 95.25 | -12.0 | <0.001 |
|                   | Change in Coefficient of Variance (CoV) (%) | Baseline vs. 1-week | 4.71 | 4.67 | 14.25 | <0.001 | 6.21 | 2.27 | 18.44 | <0.001 |
|                   | Baseline vs. 4-weeks     | 5.09 | 4.93 | 15.40 | <0.001 | 6.57 | 2.27 | 19.51 | <0.001 |
|                   | Baseline vs. 3-months    | 2.08 | 5.85 | 6.29 | 0.001 | 2.55 | 2.61 | 7.57 | <0.001 |
|                   | Change in hexagonal cellularity | Baseline vs. 1-week | -4.98 | 3.46 | -6.74 | <0.001 | -9.45 | 5.02 | -12.89 | <0.001 |
|                   | Baseline vs. 4-weeks     | -3.30 | 4.11 | -4.47 | <0.001 | -7.04 | 4.74 | -9.60 | <0.001 |
|                   | Baseline vs. 3-months    | -1.41 | 4.02 | -1.91 | 0.001 | -5.02 | 4.79 | -6.85 | <0.001 |
|                   | Change in CCT            | Baseline vs. 1-week | 9.44 | 5.25 | 1.82 | <0.001 | 15.79 | 7.53 | 3.03 | <0.001 |
|                   | Baseline vs. 4-weeks     | 5.56 | 4.44 | 1.07 | <0.001 | 9.74 | 6.24 | 1.87 | <0.001 |
|                   | Baseline vs. 3-months    | 5.13 | 15.01 | 0.99 | 0.001 | 2.25 | 13.84 | 0.43 | 0.107 |
follow-up intervals. The trends show that there was a rise in CoV during the initial postoperative period; however, it tended to reduce over time. The findings clearly show that the impact of cataract surgery on CoV was much pronounced in diabetic as compared to the non-diabetic group. Morikubo et al.⁹ and Yan et al.²⁵ in their studies found below baseline values at follow-up in diabetic patients, thus showing a mean fall in CoV rather than an increase. In the meta-analysis of 13 studies, Tang et al.¹⁵ found that at 3-months post-operative interval, the mean difference in CoV of diabetic and non-diabetic groups was 6.65%, with mean values higher in diabetic as compared to non-diabetic patients.

In the present study, we found the mean % hexagonal cells to be significantly lower in diabetic as compared to the non-diabetic group at all three follow-up intervals. In both groups, the mean values at different follow-ups were significantly lower as compared to baseline values. Pandey et al.⁵⁰ did not find a significant difference in % hexagonal cells between diabetic and non-diabetic groups at 4-weeks interval but found a significant difference between the two groups with lower mean values in diabetic as compared to non-diabetic group at 1-week and 3-months intervals. Different trends of change in hexagonal cells in different studies highlight the need to devise a more objective criteria for hexagonal cell density evaluation in view of the subjective observation dependence. Nevertheless, given the observations being done by the same observer for both groups, the present study as well as all the previous studies found hexagonality to be significantly higher in non-diabetic as compared to the diabetic group. Other studies also find that at a given time, hexagonality was higher in non-diabetic as compared to diabetic patients.

In the present study, the mean central corneal thickness was seen to be significantly higher in diabetic as compared to non-diabetic group at 1-week and 4-weeks follow-up intervals. At 3-months follow-up, the mean value was higher in diabetic patients as compared to non-diabetic patients (~0.8 µm), but the difference between the two groups was not significant statistically. With respect to intragroup changes, in both groups, there was an increase in CCT at different follow-up intervals as compared to baseline, though in percentage terms this change was nominal. Compared to the present study, Kudva et al.²⁷ found CCT of diabetic patients to be significantly higher as compared to non-diabetic patients at both 1-month as well as 3-month intervals. The reason for the higher difference in CCT of diabetic and non-diabetic patients in their study as compared to the present study could be attributable primarily to the fact that in the present study, all the diabetics had an excellent glycemic control (HbA₁c values ranging from 5.40% to 6.90%; mean value: 6.12 ± 0.38%), whereas Kudva et al.²⁷ reported the mean HbA₁c value of 7.56%, thus indicating poor glycemic control as compared to that in the present study. In fact, the better glycemic control of patients in the present study was one of the reasons for difference in some of the specific trends of changes in endothelial cell density and CCT observed in present study as compared to those reported in the literature. In fact, in such a highly controlled glycemia, the diabetic patients in the present study were too close to non-diabetic patients as hyperglycemia is considered to be one of the major factor responsible for greater cellular damage and delayed tissue regeneration. In their meta-analysis, Tang et al.¹⁵ also observed no significant difference in mean change in CCT of diabetic and non-diabetic patients at 1-week and 3-months follow-up; however, at the 1-month interval, the mean changes were significantly higher in diabetic as compared to non-diabetic group. In fact, almost all the studies including ours have seen that impact of cataract surgery on central corneal thickness is nominal and is almost neutralized by 3-months postoperative period.

In the present study, we included visual outcomes in terms of postoperative visual acuity and found that non-diabetic patients had significantly better visual outcomes as compared to diabetic patients at all three follow-up intervals. In their meta-analysis, Tang et al.¹⁵ also found short-term visual acuity (1 week) to be better in non-diabetic as compared to a diabetic group; however, they did not find it to be maintainable up to 3-months follow-up. As such visual outcome measure is one of the less-studied outcomes in studies evaluating the endothelial cell changes following cataract surgery as most of the cases have a near-perfect vision in the affected eye during this short period, further studies to evaluate these changes in long-term are recommended to elucidate further on this aspect.

The findings of the present study could be specific in view of the good glycemic control of diabetic patients and that peculiarity makes it different from other studies. The present study shows that though in the short term endothelial cell damage is higher in diabetic as compared to non-diabetic cases, with the passage of time despite slower repair in diabetic as compared to non-diabetic patients, these differences tend to neutralize. Further studies on a wider glycemic control profile of diabetic patients and their comparison with non-diabetic patients in a study with longer follow-up are recommended to explore this association further.

### Table 5: Comparison of mean BCVA (LogMAR) at preoperative and different postoperative follow-up intervals between non-diabetic and diabetic groups

| Time interval       | Group       | n  | Mean  | SD   | Minimum | Maximum | Median | P   |
|---------------------|-------------|----|-------|------|---------|---------|--------|-----|
| Pre-op.             | Non-diabetic| 100| 0.67  | 0.20 | 0.30    | 1.00    | 0.60   | 0.519 |
|                     | Diabetic    | 100| 0.69  | 0.21 | 0.30    | 1.00    | 0.60   |      |
| 1-week post-op.     | Non-diabetic| 100| 0.15  | 0.10 | 0.10    | 0.30    | 0.20   | 0.034 |
|                     | Diabetic    | 100| 0.18  | 0.09 | 0.10    | 0.30    | 0.20   |      |
| 4-weeks post-op.    | Non-diabetic| 100| 0.005 | 0.02 | 0.00    | 0.1     | 0.00   | 0.001 |
|                     | Diabetic    | 100| 0.02  | 0.02 | 0.00    | 0.1     | 0.00   |      |
| 3-months post-op.   | Non-diabetic| 100| 0.003 | 0.02 | 0.00    | 0.10    | 0.00   | 0.005 |
|                     | Diabetic    | 100| 0.014 | 0.03 | 0.00    | 0.10    | 0.00   |      |
Conclusion

The present study was carried out to compare the corneal endothelial changes after phacoemulsification in diabetic and non-diabetic patients. Postoperatively at 1 week, 4-week, and 1-month follow-up intervals, the mean endothelial cell count and coefficient of variance were significantly higher, and the mean % of hexagonal cells was significantly lower in diabetic as compared to the non-diabetic group. A significant difference in the mean central corneal thickness of the two groups was observed at 1-week and 4-weeks postoperative intervals. At both these intervals, the mean value was significantly higher in diabetic as compared to the non-diabetic group. However, at 3-months postoperative interval, the difference between the two groups was not significant statistically. Mean BCVA values were significantly higher in diabetic as compared to the non-diabetic group at all three follow-up intervals.

The findings of the present study show that endothelial cell characteristics are adversely affected in diabetic as compared to non-diabetic patients, which might also have an effect on the visual outcomes. The findings of the present study are in agreement with the findings of previous works. However, whether these differences sustain in the long-term needs further studies in a long-term longitudinal cohort study.

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Conflicts of interest

There are no conflicts of interest.

References

1. Khan A, Kose S, Jharwal MK, Meena A, Sharma A. Comparison of corneal endothelial cell counts in patients with controlled diabetes mellitus (Type 2) and non diabetics after phacoemulsification and intraocular lens implantation. International Multispecialty Journal of Health 2016;2:2395-6291.
2. Vijaya L, George R, Raju P, Ramesh SV, Arvind H, Baskaran M, et al. Prevalence and causes of blindness in Rural South Indian population. Invest Ophthalmol Vis Sci 2005;46:1100.
3. Feldman B, Heersink S, Patel A, Delmonte D, Stelzner S, Hossain K. Cataract- EyeWiki. Eyewiki.aao.org. 2018. Available from: http://eyewiki.aao.org/Cataract. Last accessed on 2019 Feb 01.
4. Khairallah M, Kahloun R, Bourne R, Limburg H, Flaxman S, Jonas J, et al. Number of people blind or visually impaired by cataract worldwide and in world regions, 1990 to 2010. Invest Ophthal Vis Sci 2015;56:6762-9.
5. Lee CM, Afshari NA. The global state of cataract blindness. Curr Opin Ophthalmol 2017;28:98-103.
6. Morikubo S, Takamura Y, Kubo E. Corneal changes after small-incision cataract surgery in patients with diabetes mellitus. Arch Ophthalmol 2004;122:9669.
7. Dua HS, Faraj LA, Said DG, Gray T, Lowe J. Human corneal anatomy redefined: A novel pre Descemet’s layer (Dua’s layer). Ophthalmology 2013;120:1778-85.
8. Alberti KG, Zimmet PZ. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: Diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. Diabetic Med 1998;15:539-53.
9. IDF Diabetes atlas- Home. Diabetesatlas.org. 2019. Available from: http://www.diabetesatlas.org. Last accessed on 2019 Feb 03.
10. Srinivas SP. Dynamic regulation of barrier integrity of the corneal endothelium. Optom Vis Sci 2010;87:E239-54.
11. Lutty GA. Effects of diabetes on the eye. Invest Ophthalmol Vis Sci 2013;54:ORSF81-7.
12. Doughty MJ, Zaman ML. Human corneal thickness and its impact on intraocular pressure measures: A review and meta-analysis approach. Surv Ophthalmol 2000;44:367-408.
13. Funderburgh JL. The corneal stroma. In: Dart DA, Besharse JC, Dana R, editors. Encyclopedia of the Eye. Boston, MA, USA: Elsevier Ltd; 2010. p. 515-21.
14. Tang Y, Chen X, Zhang X, Tang Q, Liu S, Yao K. Clinical evaluation of corneal changes after phacoemulsification in diabetic and non diabetic cataract patients, a systematic review and meta analysis. Sci Rep 2017;7:14128.
15. Lee J, Lee J, Choi H, Oum BS, Cho BM. Corneal endothelial cell changes after phacoemulsification relative to the severity of diabetic retinopathy. J Cataract Refrac Surg 2005;31:742-9.
16. Polack F, Sugar A. The phacoemulsification procedure. Corneal endothelium changes. Invest Ophthalmol 1976;6:58-69.
17. Edelhauser HF. The balance between corneal transparency and edema. Invest Ophthalmol Vis Sci 2006;47:1755-67.
18. Altintas AG, Yilmaz E, Anayol MA, Can I. Comparison of corneal edema caused by cataract surgery with different phaco times in diabetic and non‑diabetic patients. Ann Ophthalmol (Skokie) 2006;38:61-5.
19. Furuse N, Hayasaka S, Yamamoto Y, Setogawa T. Corneal endothelial changes after posterior chamber intraocular lens implantation in patients with or without diabetes mellitus. Br J Ophthalmol 1990;74:258-60.
20. Hugod M, Storr-Paulsen A, Norregaard JC, Nicolini J, Larsen AB, Thulesen J. Corneal endothelial cell changes associated with cataract surgery in patients with type 2 diabetes mellitus. Cornea 2011;30:749-53.
21. Sahu P, Das G, Agrawal S, Kumar S. Comparative evaluation of corneal endothelium in patients with Diabetes undergoing phacoemulsification. Middle East Afr J Ophthalmol 2017;24:74-80.
22. ELKady M, Saleh MM, Aboalhamd AS. Corneal endothelial cells changes after phacoemulsification in type II diabetes mellitus. Egypt J Hosp Med 2017;69:2004-11.
23. Fernández-Muñoz E, Zamora-Ortiz R, Gonzalez Salinas R. Endothelial cell density changes in diabetic and nondonabetic eyes undergoing phacoemulsification employing phaco-chop technique. Int Ophthalmol 2019;39:1735-41.
24. Al-Sharkawy HT. Corneal endothelial changes in type 2 diabetes mellitus before and after cataract surgery. J Egypt Ophthalmol Soc 2015;108:79-85.
25. Yan AM, Chen FH. Phacoemulsification on corneal endothelium cells in diabetic patients with different disease duration. Int Eye Sci 2014;14 1786-9.
26. Pandey S, Satyawalli V, Painyuli B, Titiyal GS. A prospective study of endothelial cell count in diabetic and non-diabetic patients after cataract surgery. Indian J Clin Exp Ophthalmol 2019;5:358-62.
27. Kudva AA, Lasrado AS, Hedge S, Kadri R, Devika P, Shetty A. Corneal endothelial cell changes in diabetics versus age group matched nondiabetics after manual small incision cataract surgery. Indian J Ophthalmol 2020;68:72-6.