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# Comparative Corneal Endothelial Cell Changes Following Different Cataract Surgical Modalities in Diabetic and Non-Diabetic Patients

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**Abstract:** ***This prospective observational study assessed and compared corneal endothelial changes following phacoemulsification and manual small-incision cataract surgery (SICS) in diabetic and non-diabetic patients. A total of 120 eyes were included, comprising 60 diabetic and 60 non-diabetic patients, divided into four groups of 30 each. Patients aged above 40 years with grade 1–3 cataract according to the Lens Opacities Classification System III (LOCS III) underwent uneventful phacoemulsification or manual SICS. Corneal endothelial parameters were evaluated using the TOPCON SP-1P noncontact specular microscope with pachymeter one day preoperatively and one month postoperatively. Postoperative ECD showed a reduction in all groups, which was statistically significant in Groups A and B. CCT increased in all groups, with significant changes observed in Groups A, B, and D. Hexagonality decreased across all groups, reaching statistical significance in Groups B and D, while CV increased in all groups without statistical significance,When comparing the preoperative measurements with the 1-month follow-up, significant differences were observed across all groups, but no significant inter-group differences were found for any parameter. The study concludes that endothelial cell loss is comparable between phacoemulsification and SICS irrespective of diabetic status, indicating that SICS provides similar endothelial safety while remaining as a cost-effective alternative.***

**Keywords:** Conventional Phacoemulsification, Manual Small Incision Cataract Surgery, Central Corneal Thickness, Endothelial Cell Loss, Diabetic status.

## 1. Introduction

The corneal endothelium is a single layer of neural crest–derived cells that are uniform in size and shape (hexagonal),[1] Corneal endothelial cells (CECs) play an important role in cornea transparency.[1] Corneal endothelial cells (CECs) help to keep the cornea clear and hydrated by using a pump ($Na^+/K^+$-ATPase) to move sodium and potassium ions. This pump removes excess fluid from the cornea to prevent swelling. The cells are also connected by tight junctions, but these junctions are not fully sealed, allowing a small amount of fluid to leak through. This leak helps maintain a balance between the CECs and the aqueous humor, keeping the cornea healthy and clear.

At birth, human corneal endothelial cell density is approximately 5,000 to 6,000 cells/mm². This density declines at an average rate of 0.6% per year,[2] reaching around 2,300 to 3,100 cells/mm² by the age of 40-49,[3] and further decreasing to approximately 1,500 to 2,300 cells/mm² by the age of 80-89.[3] The human corneal endothelium does not regenerate. Hence, any focal endothelial injury/loss of endothelial cell is repaired by maintaining its continuity by migration and expansion of surviving cells,[2] Endothelial health is measured by the percentage of hexagonal cells (6A), the variation in cell size (polymegathism)(CV), and cell density (CD). With age, cell density reduces, hexagonal cells decrease, and cell size variability increases.

Specular microscopy is a noninvasive diagnostic tool for corneal endothelium,[4] it provides detailed information about endothelial cell structure, density, and morphology, which is essential for diagnosing and managing various corneal and ocular diseases. Specular microscopy works on principle of reflection. It uses a microscope that captures light reflected from the corneal endothelium. The endothelial cells reflect light in a way that can be captured in high-magnification images of the corneal endothelium, these images can be analyzed both qualitatively and quantitatively using automated software to assist in diagnosing pathology, accurately monitoring endothelial disease, and aiding in surgical co-management, enabling a comprehensive evaluation of the cell's morphology and overall health.

**Endothelial Cell Morphology Analysis:**

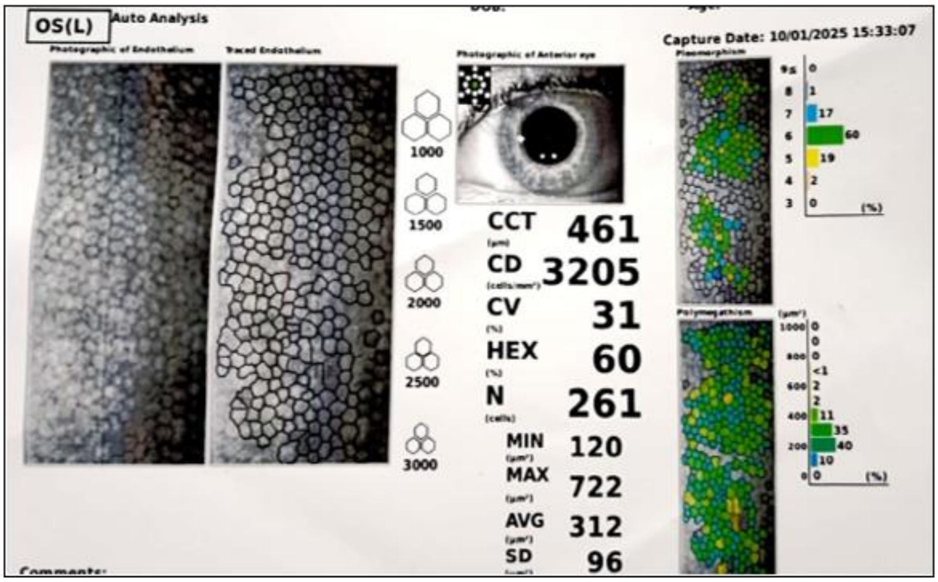


**Figure 1:** Specular microscopy report of a normal 25-year-old female. Note the uniform hexagonal cells, high CD, low CV and high HEX/6A

1) Cell density (CD): The number of endothelial cells per $mm^2$. Endothelial cell density naturally declines with age and the presence of certain diseases. When assessing cell density, it is essential to compare age-specific reference values. A cell density below 1,000 cells/mm² increases the risk of developing pseudophakic bullous keratopathy,[3] while a density of 300 to 600 cells/mm² is essential to maintain proper corneal hydration.[3] If cell density falls below this critical value leads to corneal edema and loss of corneal transparency.[3]

2) Coefficient of variation (CV): Amount of variation in cell size. The coefficient of variation is a measure of polymegethism.

$$CV = \frac{\text{Standard deviation of cell area}}{\text{Mean cell area}}$$

A coefficient of variation less than 33 is normal, but an increase in this value is an early indicator of endothelial disease, signifying endothelial cell remodeling.

3) HEX or 6A: Number of cells that have a hexagonal shape, A healthy cornea usually has around 60% hexagonal cells. Decrease of hexagonal cells (Pleomorphism). As pleomorphism increases, hexagonality decreases, the barrier function of the corneal endothelium is compromised, HEX or 6A value below 50% is considered abnormal.

4) Central corneal thickness (CCT): Normal CCT is 564 ± 32.637 µm. [5] A thickened central cornea may indicate corneal edema and impaired endothelial function.

5) Average cell area (AVG): Measurement of the average cell area. This number increases with age.[3]

6) Standard deviation of mean cell area (SD): The standard deviation of mean cell area within the analysis.[3]

Prior to cataract surgery, a thorough evaluation of the corneal endothelium is crucial to identify any potential risk factors for postoperative corneal decompensation.

Cataract, one of the most common eye diseases and the leading cause of blindness worldwide,[6] cataract extraction can be done by either manual Small incision cataract surgery(SICS) or CONVENTIONAL phacoemulsification technique,[6] in manual SICS, most maneuvering is performed manually in the anterior chamber damages endothelium,[7] In conventional phacoemulsification, the maneuvering is mechanical and performed in the capsular bag, far from the endothelium but endothelial cell loss can occur due to injury from ultrasound energy.[7] Some degree of endothelial cell loss is inevitable after any type of cataract surgery (up to 10%).[3] Cataract patients are often associated with systemic conditions, with diabetes being one of the most prevalent.

The International Diabetes Federation (IDF) reports that India currently has 77 million people aged 20-79 with diabetes, and this number is expected to rise to 134.2 million by 2045, placing India at the forefront of the global diabetes challenge.[8] Diabetes mellitus (DM) is a progressive and chronic metabolic disease characterized by hyperglycemia,[6] these patients are at a higher risk of suffering from various complications, such as diabetic cardiopathy, diabetic nephropathy (DN) and diabetic keratopathy (DK).[6] In diabetic patients there is irregularities in cell shape, a decrease in the percentage of hexagons, and the increase of central corneal thickness, and impaired morphology of corneal mitochondria in endothelium.[6]

Cataract surgery in diabetic patients has a cumulative effect on the corneal endothelium, potentially leading to endothelial cell loss and compromising corneal health over time.

## 2. Materials and Methods

This prospective observational study involved 120 eyes of patients aged over 40 years, with cataract grades 1-3 as classified by the Lens Opacities Classification System (LOCS3). The study was approved by the local ethics council, and all patients provided written informed consent prior to participation. Participants selected from either the OPD or the camp, The demographic profile of all patients was recorded. Following a thorough preoperative assessment for cataract surgery in the outpatient department, Participants with preoperative anterior chamber depth (ACD) of at least 2.5 mm and a preoperative endothelial cell density (ECD) of at least 2000 cells/mm² were included. For diabetic patients, details such as the onset and duration of diabetes and one random blood glucose reading was taken, while in non-diabetic patients, three readings were obtained using a glucometer. Preoperative specular microscopy (Topcon SP1P) was performed to evaluate endothelial density (ED), coefficient of variation (CV), central corneal thickness (CCT), and the percentage of hexagonal cells (%Hex), patients with pseudo-exfoliation, uveitis, corneal opacities, glaucoma or corneal inflammations were excluded.

Community patients were given the option of paying for phacoemulsification or opting for free manual SICS. Both procedures and their expected outcomes, which are anticipated to be nearly identical, were explained to the patients. Community patients who choose manual SICS would undergo that procedure, while outpatient department (OPD) patients would undergo conventional phacoemulsification. After uneventful cataract surgery either conventional phacoemulsification or manual SICS.

Patients were divided into four groups, each consisting of 30 participants. Group A included diabetic patients who underwent conventional phacoemulsification; Group B consisted of non-diabetic patients who underwent conventional phacoemulsification; Group C comprised diabetic patients who underwent manual Small Incision Cataract Surgery (SICS); and Group D consisted of non-diabetic patients who underwent manual SICS.

Follow-up visits were scheduled one-month post-surgery. During the visit, best-corrected visual acuity (BCVA), slit-lamp examination, and specular microscopy for endothelial evaluation were conducted. Data were entered into Excel and analysed using SPSS version 24.0. P<0.05 was considered as statistically significant difference loss of endothelial cells across the four groups during the postoperative follow-up, with a 95% confidence level and 80% power, particularly concerning corneal endothelial cell changes in diabetic versus age-matched non-diabetic patients after manual SICS (Ajay A. Kudva et al.).[10]

Descriptive statistics were calculated, and group comparisons were conducted using either the ANOVA test with Tukey's post-hoc analysis or the Kruskal-Walli's test, depending on the data distribution. The Chi-square test was used for qualitative data analysis.

The surgeries were performed between June to December 2024 at a tertiary care research institute

## 3. Results

Out of 120, 55% females and 45% males participated and the mean age of the participants among the Group A was 62 ±7.71 years and the Group B was 58.23 ± 8.6years, group C was 63.03 ± 7.6 years and group D was 61.43 ± 9.44 years. The difference in age between the groups was not statistically significant (p=0.147) respectively as shown in Table 1.

**Table 1:** Mean Age Distribution Among the Groups

| | No of participants | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Group A | 30 | 62.00 | 7.710 | 44 | 74 |
| Group B | 30 | 58.23 | 8.629 | 45 | 73 |
| Group C | 30 | 63.03 | 7.686 | 48 | 80 |
| Group D | 30 | 61.43 | 9.442 | 47 | 80 |

*Group A- diabetic patients underwent phacoemulsification; † Group B – non-diabetic patients underwent phacoemulsification; ‡ Group C- diabetic patients underwent manual Small Incision Cataract Surgery; § Group D- non-diabetic patients underwent manual Small Incision Cataract Surgery

In groups A, majority were of grade 2 Nuclear Sclerosis (LOCS - 3), in group B, group C, group D majority were grade 3 Nuclear Sclerosis (LOCS - 3) which is described in figure 2.

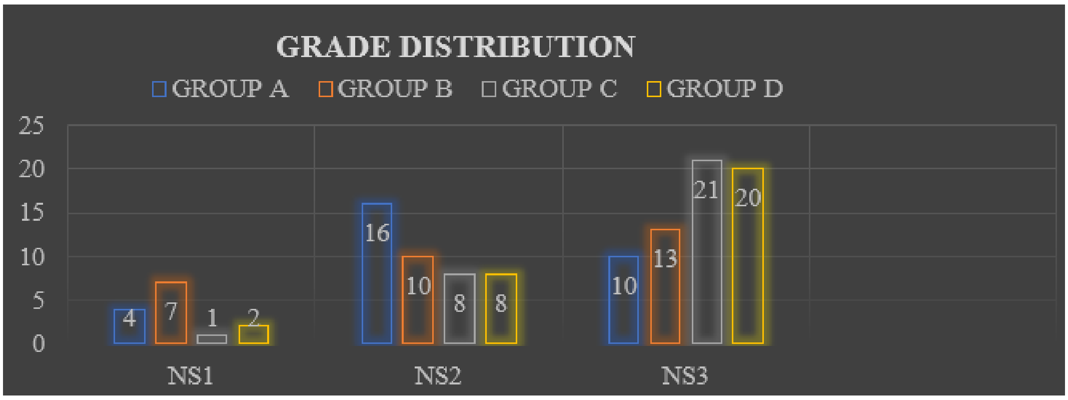


**Figure 2:** (GRADE distribution)

Mean pre-operative Corneal Endothelial count represented as Corneal Density In the specular report (table 2) in Group A was 2759 ± 413.392 (Range:2605.30 to 2914.03) cells/mm 2, group B was 2642.73 ± 314.08 (Range:2525.45 to 2760.01)cells/mm 2 , group C was 2643 ± 299.3(range: 2531.22 to 2754.77)cells/mm 2 and group D was 2749.50 ± 269.13(Range: 2649 to 2849.99)cells/mm 2 was almost similar in all the 4 groups(table 2) and Mean pre operative Central Cornea Thickness in group A was 496.33 ± 37.4µ, group B was 505.5 ± 34.7µ, group C was 497.13 ± 27.9µ and group D was 495.66 ± 44.3µ(TABLE 3). The Mean pre-operative Hexagonality in group A was 52.76 ± 9.8%, group B was 55.20 ± 9.4%, group C was52.2 ±8.5% and group D was 52.56 ± 4.19% which suggests similar hexagonality in 4 groups (TABLE 4). The mean coefficient of variance in group A was 35.1 ± 4.9, in group B was 31.1 ± 3.9, in group C was 33.8 ± 3.7 and in group D was 33.7 ± 4.8 was similar in 4 groups (TABLE 5).

**Table 2:** Mean Endothelial Cell Density (CD) among the groups

| | | No. of Partici-pants | Mean | Std. Dev. | 95% Confidence Interval for Mean | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| CD Pre | Group A | 30 | 2759.667 | 413.392 | 2605.304 | 2914.030 |
| | Group B | 30 | 2642.733 | 314.082 | 2525.453 | 2760.013 |
| | Group C | 30 | 2643.000 | 299.342 | 2531.224 | 2754.776 |
| | Group D | 30 | 2749.500 | 269.135 | 2649.003 | 2849.997 |
| CD Post | Group A | 30 | 2641.800 | 414.810 | 2486.908 | 2796.692 |
| | Group B | 30 | 2555.033 | 306.625 | 2440.538 | 2669.529 |
| | Group C | 30 | 2575.133 | 343.502 | 2446.868 | 2703.399 |
| | Group D | 30 | 2686.133 | 261.312 | 2588.558 | 2783.709 |

*Group A – diabetic patients underwent phacoemulsification; † Group B – non-diabetic patients underwent phacoemulsification; ‡ Group C – diabetic patients underwent manual Small Incision Cataract Surgery; § Group D – non-diabetic patients underwent manual Small Incision Cataract Surgery; ‖ CD Pre = preoperative cell density, ¶ CD Post = postoperative cell density.

**Table 3:** Mean Central Corneal Thickness (CCT) Among the Groups

| | | No. of Participants | Mean | Std. Dev. | 95% Confidence Interval for Mean | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| -CCT pre | Group A | 30 | 496.333 | 37.411 | 482.364 | 510.303 |
| | Group B | 30 | 505.500 | 34.780 | 492.513 | 518.487 |
| | Group C | 30 | 497.133 | 27.927 | 486.705 | 507.561 |
| | Group D | 30 | 495.667 | 44.336 | 479.111 | 512.222 |
| CCT post | Group A | 30 | 500.867 | 38.847 | 486.361 | 515.372 |
| | Group B | 30 | 514.567 | 36.440 | 500.960 | 528.173 |
| | Group C | 30 | 500.433 | 28.081 | 489.948 | 510.919 |
| | Group D | 30 | 500.733 | 42.423 | 484.892 | 516.574 |

*Group A – diabetic patients underwent phacoemulsification; † Group B – non-diabetic patients underwent phacoemulsification; ‡ Group C – diabetic patients underwent manual Small Incision Cataract Surgery; § Group D – non-diabetic patients underwent manual Small Incision Cataract Surgery; ‖ CCT Pre = Pre-operative Central Corneal Thickness, ¶ CCT post = Post operative Central Corneal Thickness.

**Table 4:** Mean Hexagonality (HEX) among the Groups

| | | No. of Participants | Mean | Std. Dev. | 95% Confidence Interval for Mean | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| HEX Pre | Group A | 30 | 52.767 | 9.835 | 49.094 | 56.439 |
| | Group B | 30 | 55.200 | 9.426 | 51.680 | 58.720 |
| | Group C | 30 | 52.200 | 8.507 | 49.023 | 55.377 |
| | Group D | 30 | 52.567 | 4.191 | 51.002 | 54.132 |
| HEX Post | Group A | 30 | 50.300 | 7.493 | 47.502 | 53.098 |
| | Group B | 30 | 50.867 | 8.641 | 47.640 | 54.093 |
| | Group C | 30 | 49.933 | 6.400 | 47.544 | 52.323 |
| | Group D | 30 | 48.567 | 5.630 | 46.464 | 50.669 |

*Group A – diabetic patients underwent phacoemulsification; † Group B – non-diabetic patients underwent phacoemulsification; ‡ Group C – diabetic patients underwent manual Small Incision Cataract Surgery; § Group D – non-diabetic patients underwent manual Small Incision Cataract Surgery; ‖ HEX Pre = Pre-operative Hexagonality, ¶ HEX Post = Post operative Hexagonality.

**Table 5:** Mean Coefficient of variance (CV) Among the Groups

| | | No. of Participants | Mean | Std. Dev. | 95% Confidence Interval for Mean | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| CV Pre | Group A | 30 | 35.1 | 4.915 | 33.265 | 36.935 |
| | Group B | 30 | 31.1 | 3.933 | 29.631 | 32.569 |
| | Group C | 30 | 33.867 | 3.776 | 32.457 | 35.277 |
| | Group D | 30 | 33.7 | 4.815 | 31.902 | 35.498 |
| CV post | Group A | 30 | 34.5 | 4.134 | 32.957 | 36.043 |
| | Group B | 30 | 30.833 | 3.343 | 29.585 | 32.082 |
| | Group C | 30 | 33.4 | 4.889 | 31.574 | 35.226 |
| | Group D | 30 | 32.733 | 4.378 | 31.099 | 34.368 |

*Group A- diabetic patients underwent phacoemulsification; † Group B – non-diabetic patients underwent phacoemulsification; ‡ Group C – diabetic patients underwent manual Small Incision Cataract Surgery; § Group D – non-diabetic patients underwent manual Small Incision Cataract Surgery; ‖ CV Pre = Pre-Operative Coefficient of variance, ¶ CV Post = Post-Operative Coefficient of variance.

The intra group difference in endothelial cell count, reflecting cell loss, was observed between the pre-operative period and the 1-month follow-up across all groups (Table 6). Endothelial cell density decreased in all groups post-operatively, with a statistically significant decrease in Group A ($p = 0.012$) and Group B ($p = 0.047$). Central corneal thickness increased in all four groups, with a statistically significant increase in Group A ($p = 0.013$), Group B ($p = 0.018$) and Group D ($p = 0.022$). Hexagonality decreased in all groups, with statistical significance observed in Group B ($p = 0.015$) and Group D ($p < 0.001$). The coefficient of variation increased in all groups, but the change was not statistically significant.


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**Table 6:** Intra Group Comparison of specular parameters

| Groups | | Paired t Test | | t | P |
|---|---|---|---|---|---|
| | | Mean | Std. Deviation | | |
| Group A | -CCT pre - CCT post | -6.533 | 16.055 | -1.547 | .013* |
| | CD Pre - CD Post | 117.867 | 239.303 | 2.698 | .012 * |
| | HEX Pre – HEX Post | 2.467 | 10.67 | 1.266 | 0.216 |
| | CV Pre – CV post | 0.6 | 3.379 | 0.972 | 0.339 |
| Group B | -CCT pre - CCT post | -9.067 | 19.867 | -2.5 | .018 * |
| | CD Pre – CD Post | 87.7 | 231.289 | 2.077 | .047 * |
| | HEX Pre – HEX Post | 4.333 | 9.155 | 2.593 | .015 * |
| | CV Pre – CV post | 0.267 | 3.473 | 0.421 | 0.677 |
| Group C | -CCT pre - CCT post | -3.3 | 13.906 | -1.3 | 0.204 |
| | CD Pre – CD Post | 67.867 | 268.686 | 1.383 | 0.177 |
| | HEX Pre – HEX Post | 2.267 | 8.67 | 1.432 | 0.163 |
| | CV Pre – CV post | 0.467 | 3.919 | 0.652 | 0.519 |
| Group D | -CCT pre - CCT post | -5.067 | 11.45 | -2.424 | .022 * |
| | CD Pre – CD Post | 63.367 | 190.78 | 1.819 | 0.079 |
| | HEX Pre – HEX Post | 4 | 5.452 | 4.019 | <0.001 *** |
| | CV Pre – CV post | 0.967 | 2.798 | 1.893 | 0.068 |

*Group A- diabetic patients underwent phacoemulsification; † Group B – non-diabetic patients underwent phacoemulsification; ‡ Group C – diabetic patients underwent manual Small Incision Cataract Surgery; § Group D – non-diabetic patients underwent manual Small Incision Cataract Surgery; ‖ CD Pre = preoperative cell density, ¶ CD Post = postoperative cell density, ** CCT Pre = Pre-operative Central Corneal Thickness, †† CCT post = Post operative Central Corneal Thickness, ; ‡‡ HEX Pre = Pre-operative Hexagonality, §§ HEX Post = Post operative Hexagonality, ‖‖ CV Pre = Pre-Operative Coefficient of variance, ¶¶ CV Post = Post-Operative Coefficient of variance
*- Significant, ** - Highly significant, *** Very highly significant.

Difference was observed when comparing the pre-operative period with the 1-month follow-up across all groups. In the inter-group comparison (Table 7), no statistically significant differences were found between the groups in parameters such as endothelial cell density, central corneal thickness, hexagonality, and coefficient of variation.

**Table 7:** Inter group comparison of specular parameters

| Multiple Comparisons - Tukey HSD | | | | |
|---|---|---|---|---|
| Dependent Variable | Group | Group | Mean Difference | Sig. |
| CCT diff | Group A | Group B | 4.533 | 0.676 |
| | | Group C | -1.233 | 0.99 |
| | | Group D | 0.533 | 0.999 |
| | Group B | Group C | -5.767 | 0.484 |
| | | Group D | -4 | 0.755 |
| | Group C | Group D | 1.767 | 0.972 |
| CD diff | Group A | Group B | 30.167 | 0.959 |
| | | Group C | 50 | 0.842 |
| | | Group D | 54.5 | 0.804 |
| | Group B | Group C | 19.833 | 0.988 |
| | | Group D | 24.333 | 0.978 |
| | Group C | Group D | 4.5 | 1 |
| HEX diff | Group A | Group B | -1.867 | 0.84 |
| | | Group C | 0.2 | 1 |
| | | Group D | -1.533 | 0.903 |
| | Group B | Group C | 2.067 | 0.794 |
| | | Group D | 0.333 | 0.999 |
| | Group C | Group D | -1.733 | 0.867 |
| CV diff | Group A | Group B | 0.333 | 0.982 |
| | | Group C | 0.133 | 0.999 |
| | | Group D | -0.367 | 0.976 |
| | Group B | Group C | -0.2 | 0.996 |
| | | Group D | -0.7 | 0.857 |
| | Group C | Group D | -0.5 | 0.942 |

*Group A – diabetic patients underwent phacoemulsification; † Group B – non-diabetic patients underwent phacoemulsification; ‡ Group C – diabetic patients underwent manual Small Incision Cataract Surgery; § Group D – non-diabetic patients underwent manual Small Incision Cataract Surgery; ‖ CD diff = differential preoperative to postoperative cell density, ¶ CCT diff = differential pre-operative to post operative central corneal thickness, ** HEX diff = differential pre-operative to post operative Hexagonality, †† CV diff = differential pre-operative to post-operative Coefficient of variance.

On inter group comparison of endothelial cell loss, difference was observed between pre operative and 1 month follow up period but it was not statistically significant as shown in Table 7. The parameters like age of the subjects, gender, socio-economic status and grade, did not have statistical significance for the corneal endothelial Cell loss in between the four Groups.

## 4. Discussion

Cataract is one of the most common eye diseases and the leading cause of blindness worldwide. Cataract extraction can be performed using either the manual Small Incision Cataract Surgery (SICS) or the conventional phacoemulsification technique. While some degree of endothelial cell loss is inevitable after any cataract surgery, diabetes mellitus can also impact the corneal endothelium. Understanding how different cataract surgery techniques affect corneal health in diabetic versus non-diabetic patients is essential for optimizing surgical outcomes. By comparing conventional phacoemulsification and manual SICS using specular microscopy, we can enhance safety, tailor surgical approaches, and improve visual outcomes. To the best of our knowledge, no studies have yet compared the effects of both procedures on the corneal endothelium in diabetic and non-diabetic patients.



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Our study demonstrates a significant increase in central corneal thickness at 1month post-operative follow-up in both diabetics (group A) ($P = 0.013$) and non-diabetics (group B) ($P = 0.018$) who underwent phacoemulsification is statistically significant, indicating transient edema in both groups. However, the difference in central corneal thickness between the two groups (group A with group B) was not statistically significant. These findings align with Elminshawy et al,[9] who also observed a significant increase in central corneal thickness in both non-diabetics and diabetics after phacoemulsification ($P > 0.05$ for both), with no statistically significant difference in central corneal thickness between the groups.

Additionally, our study shows significant endothelial cell loss at 1 month in both diabetics (group A) ($P = 0.012$) and non-diabetics (group B) ($P = 0.047$) following phacoemulsification, which confirms that ultrasound energy used during phacoemulsification has a lethal effect on endothelial cells. On comparing the cell loss between diabetic and non-diabetic patients undergoing phacoemulsification, the loss of endothelial cells was not statistically significant which indicates that both are at equal risk of cell loss independent of glycemic status. In contrast, Elminshawy et al [9] reported no significant endothelial cell loss in non-diabetic patients (group A, $P > 0.05$) and significant loss in diabetic patients (group B, $P < 0.05$), with no statistically significant difference in endothelial loss between the two groups.

In our study, there was no statistically significant decrease in endothelial cell or increase in central corneal thickness between diabetic (group C) and non-diabetic (group D) patients who underwent MSICS ($P > 0.05$) at 1-month post-operative follow-up which indicates that SICS can also be safely performed irrespective whether patient is diabetic or non-diabetic. However, the study by Ajay Kudva et al. [10] found a statistically significant decrease in endothelial cell ($P < 0.05$) and an increase in central corneal thickness ($P < 0.05$) in diabetic patients compared to non-diabetic patients who underwent MSICS after 1 month. Notably, their study included both mature and hyper- mature cataracts, whereas our study focused exclusively on NS cataract grades I-III.

In our study, the mean endothelial cell loss was 87.70 cells/mm² in the non-diabetic phacoemulsification group (group B) and 63.37 cells/mm² in the non-diabetic MSICS group (group D), with no statistically significant difference between the two which was Similarly shown by Somil N. Jagani et al [11] in their study. This observation shows that manual SICS is as safe as newer modality of phacoemulsification surgery in terms of endothelial damage. So, patients who cannot afford the expenses of phacoemulsification surgery can be offered the option of manual SICS for cataract treatment. Hence performing manual SICS in community, high volume set up is justifiable.

In our study, the preoperative mean central corneal thickness (CCT) was $505.50 \pm 34.7$ µm in the phacoemulsification group (group B) and $495.66 \pm 44.3$ µm in the MSICS group (group D). One month postoperatively, the mean CCT increased to $514.56 \pm 36.4$ µm ($P=0.018$) in the phacoemulsification group (group B) and $500.73 \pm 73.0$ µm ($P=0.022$) in the MSICS group (group D). The postoperative increase in CCT was attributed to transient corneal edema in both groups. Similar results were observed in Kumar et al.'s [12] study, where a significant increase in CCT was noted after phacoemulsification ($P<0.001$) and MSICS ($P<0.001$) at 3 weeks. In our study, endothelial cell loss after 1 month was significantly lower in the MSICS group (group D) ($P>0.05$) compared to phacoemulsification (group B) ($P=0.047$), although the differential endothelial loss between the two groups was not statistically significant. Kumar et al. [12] also found less endothelial cell loss at 3 weeks in the MSICS group compared to phacoemulsification, with a statistically significant difference ($P<0.001$)

As mentioned earlier, SICS and Phacoemulsification are equally safe in non-diabetic patients, on the contrary, among the diabetic patients we observed significant endothelial cell loss (Group A) between pre operative and 1 month follow up of patient who underwent phacoemulsification compared to manual SICS (group C) ($p = 0.012$). This alarming observation is uniquely noted only in our study to the best of our knowledge. It will help the surgeons to plan phacoemulsification in diabetic patients with extra precautions. Use of endothelium protectors like dispersive Visco elastics can be used liberally in such cases. Post operatively, long term follow up of endothelium status can be recommended in such patients especially in cases of hard cataracts. However, the differences in endothelial cell loss of diabetic patients at the end of 1 month was not statistically significant irrespective of whether they underwent phacoemulsification or manual SICS. This shows that in diabetic patients also both procedures are equally safe with regards to endothelium damage in case of medium grade cataracts.

## 5. Conclusion

Although phacoemulsification offers advanced technology, the large backlog of cataract blindness in developing countries makes manual Small Incision Cataract Surgery (SICS) a more practical option due to its lower cost and less reliance on technology. Our study showed no significant difference in endothelial cell loss or visual acuity outcome between phacoemulsification and manual SICS after one month, in both diabetic and non-diabetic patients. Therefore, manual SICS is a cost-effective and reliable choice for cataract surgery in resource-limited settings, as long as proper patient selection, skilled surgery, and good postoperative care are provided.

Our study suggests that patients in the community who are not affordable can undergo SICS. They will experience outcomes comparable to those undergoing phacoemulsification.

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None.

**Conflict of Interest**
None.

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## References

[1] Goldstein AS, Janson BJ, Skeie JM, Ling JJ, Greiner MA. The effects of diabetes mellitus on the corneal endothelium: A review. Surv Ophthalmol. 2020 Jul-Aug;65(4):438-450

[2] Chaurasia, Sunita; Vanathi, Murugesan1. Specular microscopy in clinical practice. Indian Journal of Ophthalmology 69(3): p 517-524, March 2021.

[3] What Specular Microscopy Reveals About Your Patients
Visualizing the corneal endothelium aids in the diagnosis and management of myriad diseases. by Daniel Epshtein, OD, Published September 15, 2019 in review of cornea and contact lenes

[4] Specular microscopy in clinical practice Sunita Chaurasia, Murugesan Vanathi Indian J Ophthalmol,2021 Mar;69(3)

[5] Camburu G, Zemba M, Tătaru CP, Purcărea VL. The measurement of Central Corneal Thickness. Rom J Ophthalmol. 2023 Apr-Jun;67(2):168-174.

[6] Chen C, Zhou Q, Li Z, Duan H, Liu Y, Wan L, et.al, Hyperglycaemia induces corneal endothelial dysfunction through attenuating mitophagy. Exp Eye Res. 2022 Feb; 215:108903

[7] Joo JH, Kim TG. Comparison of corneal endothelial cell changes after phacoemulsification between type 2 diabetic and nondiabetic patients. Medicine (Baltimore). 2021 Sep 3;100(35): e27141.

[8] Muralidharan, Shrikanth. Diabetes and current Indian scenario: A narrative review. Journal of Diabetology 15(1): p 12-17, January-March 2024.

[9] Elminshawy, Asmaa Ibrahima; Hegazy, Hanan Saiedb; Aly, Mona Mohamadb. Comparison of corneal changes after phacoemulsification in diabetic and nondiabetic eyes. Al-Azhar Assiut Medical Journal 20(1): p 134-141, Jan–Mar 2022.

[10] Kudva AA, Lasrado AS, Hegde 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 Jan;68(1):72-76

[11] Jagani, Somil N.; Lune, Abhay A.; Magdum, Renu M, et.al, Comparison of Endothelial Cell Loss by Specular Microscopy between Phacoemulsification and Manual Small-Incision Cataract Surgery, Nigerian Journal of Ophthalmology 23(2): p 54-59, Jul–Dec 2015

[12] Kumar, Ram; Wahi, Dipti; Tripathi, Punita. Comparison of changes in endothelial cell count and central corneal thickness after phacoemulsification and small-incision cataract surgery: A prospective observational study at a tertiary care center of eastern Uttar Pradesh. Indian Journal of Ophthalmology 70(11): p 3954-3959, November 2022.

[13] Jaggernath J, Gogate P, Moodley V, Naidoo KS. Comparison of cataract surgery techniques: safety, efficacy, and cost-effectiveness. Eur J Ophthalmol. 2014 Jul-Aug;24(4):520-6.

[14] Wilson RS, Roper-Hall MJ. Effect of age on the endothelial cell count in the normal eye. Br J Ophthalmol. 1982; 66:513-515.