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Comparative Analysis of Endothelial Cell Density and Central Corneal Thickness Following Cataract Surgery in Patients with and without Diabetes

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ABSTRACT

Background: This study aimed to compare corneal endothelial cell count density, morphology, and central corneal thickness (CCT) changes in diabetic versus non-diabetic patients undergoing cataract surgery.

Methods: A prospective study included 30 diabetic and 30 non-diabetic patients aged 40-70 years undergoing small incision cataract surgery. Diabetic patients were assessed based on HbA1C levels, diabetes duration, insulin dependency, and retinopathy grades. Specular microscopy was conducted preoperatively and 4 weeks postoperatively to evaluate endothelial parameters.

Results: In diabetic patients, 4 weeks post-surgery, mean endothelial cell density (ECD), coefficient of variance (CV), CCT, and hexagonality were 1595.93 cells/mm^2, 45.13%, 518.67 µm, and 35.43%, respectively. Non-diabetic patients showed 1929.97 cells/mm2 values, 40.37%, 493.67 µm, and 43.17%, respectively. Statistically significant differences were observed in ECD, CCT, and morphological parameters between diabetic and non-diabetic groups (P<0.001). No significant differences were found in endothelial parameters between diabetic patients with HbA1c levels <7.5% and >7.5% at 4 weeks post-surgery.

Conclusion: Diabetic patients exhibited significantly higher corneal endothelial cell changes than non-diabetic patients. ECD loss, increased CV%, and mean CCT were more pronounced in diabetic patients. Hexagonality percentage was lower in diabetic patients. These alterations mimic those seen with aging. Additionally, diabetic patients showed slower endothelial healing compared to non-diabetic counterparts following cataract surgery.

Key-words: Cataract, Corneal Thickness, Endothelial Density, Hexagonality, Coefficient of Variance, Diabetes

INTRODUCTION

There are 285 million diabetics in the world who have the disease. According to projections by the International Diabetes Federation, this figure will nearly treble to 439 million individuals by 2030 [1,2].

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Cataracts usually manifest sooner in life and are 2.5–5 times more common in diabetic patients [3]. Dependability: Because they grow more quickly, are more common, and typically require surgical removal, cataracts are considered the primary cause of vision impairment in people with diabetes [4,5]. Throughout a person's lifespan, endothelial cells actively remove excess fluid from the corneal stroma through an active transport mechanism and barrier function, assisting the stroma in becoming dehydrated [6].

Although the degree of cell loss varies according to the surgical approach, endothelial cell loss (ECL) is a foreseeable side effect of cataract surgery [7-8].

Motif criteria are more accurate in assessing endothelial function and the degree of surgical damage. Further reports of endothelial cell degeneration are associated with age [9].

Polymegathism and pleomorphism are examples of morphologically aberrant cells that can be found in the corneas of diabetic patients [10]. This study evaluated the central corneal thickness, endothelial morphology changes, and corneal endothelium loss in diabetes individuals who underwent manual small incision cataract surgery. It also tried to determine whether the patients' HbA1C levels impacted the outcomes by comparing the patients with volunteers who did not have diabetes.

MATERIALS AND METHODS

Place of study- A prospective, comparative, and interventional study was conducted at the Department of Ophthalmology of a tertiary care eye Hospital over one year from May 2021 to April 2022.

The study comprised 30 diabetic patients and 30 non-diabetic patients aged between 40 and 70. Nonetheless, Non-Contact Specular microscopy (Tomey EM3000) was employed for all participants, facilitating precise evaluation of corneal endothelial parameters preoperatively and 4 weeks post-cataract surgery.

Inclusion Criteria

- Participants with visually significant senile cataract.
- Clear cornea without any opacity.
- The absence of ocular pathology was confirmed through clinical pre-operative assessment.

Exclusion Criteria

- Presence of anterior segment pathology such as uveitis.
- History of ocular trauma.
- Subluxated lens.
- Corneal opacity.
- Evidence of posterior segment pathology.
- Contact lens wearers.
- History of intraocular surgery.

Statistical Analysis- Data analysis was performed using SPSS software- IBM SPSS V26.0. Data was analysed using an unpaired t-test. The data were considered statistically significant with p value ≤0.05.

Ethical Approval- Informed consent was obtained from all participants before undergoing the necessary investigations. The study protocol received approval from the relevant ethical review board, ensuring compliance with ethical guidelines throughout the study period.

RESULTS

The study enrolled a total of 30 eyes from patients diagnosed with diabetes and 30 eyes from non-diabetic individuals aged 40 to 70 years. Among the diabetic patients, 13 (43.3%) were male, and 17 (56.7%) were female, with a mean age of 55.63 +/- 8.0 years. In the control group (non-diabetic), there were 15 (50%) male and 15 (50%) female participants, with a mean age of 55.60 +/- 8.26 years. The mean (SD) level of HbA1c percentage in the diabetic group was 7.28% (0.78).

Before surgery, significant differences were observed in the mean (SD) values of endothelial cell density, coefficient of variation (CV), and central corneal thickness (CCT) between the diabetic and non-diabetic groups (p= 0.001). However, there were no statistically significant differences in the mean (SD) hexagonality percentage between the two groups before surgery (p= 0.976) (Table 1).

Table 1: Mean endothelial cell density, hexagonality, CV and CCT before surgery.

Pre-operative	Group		p-value
	Diabetic (n=30)	Non-Diabetic (n=30)	
Endothelial density (cells/mm^2)- mean (SD)	2514.80+/-164.87	2653.60+/-124.31	0.001
Hexagonality (%)-mean (SD)	45.57+/-4.32	45.60+/-4.31	0.976
CV (%)-mean (SD)	43.13+/-4.2	39.17+/-4.41	0.001
CCT (µm)- mean (SD)	516.43+/-23.9	492.17+/-29.38	0.001

After cataract surgery, significant differences were noted in the mean (SD) values of endothelial cell density, hexagonality, CV, and CCT between the diabetic and non-diabetic groups at 4 weeks post-surgery (p=0.001) (Table 2).

Table 2: Mean endothelial cell density, hexagonality, CV and CCT 4 weeks after surgery.

4 weeks Post-operative	Group		p-value
	Diabetic (n=30)	Non-Diabetic (n=30)	
Endothelial density (cells/mm^2)- mean (SD)	1595.93+/-159.66	1929.97+/-134.63	0.001
Hexagonality (%)-mean (SD)	35.43+/-4.19	43.17+/-4.33	0.001
CV (%)-mean (SD)	45.13+/-4.07	40.37+/-4.39	0.001
CCT (µm)- mean (SD)	518.67+/-23.54	493.67+/-29.17	0.001

Similarly, no statistically significant differences were observed in the mean (SD) values of endothelial cell density, hexagonality, CV, and CCT between the groups with HbA1c levels <7.5% and >7.5% at 4 weeks post-surgery (Table 3).

Table 3: Mean endothelial cell density, hexagonality, CV and CCT 4 weeks after surgery based on HbA1c level.

	Group		p-value
	HbA1c <7.5% (n=17)	HbA1c >7.5% (n=13)	
Endothelial density (cells/mm^2)- mean (SD)	1574.88+/-175.23	1623.46+/-138.62	0.419
Hexagonality (%)-mean (SD)	34.71+/-4.15	36.38+/-4.21	0.285
CV (%)-mean (SD)	44.82+/-3.39	45.54+/-4.94	0.642
CCT (µm)- mean (SD)	514.71+/-25.8	523.85+/-20	0.30

A significant relationship was found between the mean (SD) values of endothelial cell density, hexagonality, CV, and CCT and the presence of diabetic retinopathy at 4 weeks post-surgery (p= 0.001) (Table 4).

Table 4: Mean endothelial cell density, hexagonality, CV and CCT 4 weeks after surgery based on Diabetic retinopathy status.

	Group		
	No Diabetic Retinopathy (n=9)	Mild Diabetic Retinopathy (n=12)	Moderate Diabetic Retinopathy (n=9)
Endothelial density (cells/mm^2)- mean (SD)	1790.78+/-91.64	1555.17+/-82.76	1455.44+/-84.80
Hexagonality (%)-mean (SD)	34.56+/-5.34	35.92+/-3.55	35.67+/-4.06
CV (%)-mean (SD)	44.89+/-3.58	46.25+/-3.81	43.89+/-4.85
CCT (µm)- mean (SD)	520.56+/-29.95	522.25+/-10.03	512+/-30.02

Additionally, a significant relationship existed between the mean (SD) values of endothelial cell density, hexagonality, CV, CCT, and the duration of diabetes mellitus at 4 weeks post-surgery (p=0.001) (Table 5).

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Table 5: Mean endothelial cell density, hexagonality, CV and CCT 4 weeks after surgery based on Duration of Diabetes mellitus.

	Group	
	>10 years DM (n=14)	**<10 years DM (n=16)**
Endothelial density (cells/mm^2)- mean (SD)	1652.71+/-181.34	1546.25+/-123
Hexagonality (%)-mean (SD)	34.64+/-4.32	36.13+/-4.08
CV (%)-mean (SD)	45.29+/-3.51	45+/-4.61
CCT (µm)- mean (SD)	511.29+/-24.79	525.13+/-21.07

There was a significant relationship between the mean (SD) values of endothelial cell density, hexagonality, CV, CCT, and insulin dependency at 4 weeks post-surgery (p=0.001) (Table 6).

Table 6: Mean endothelial cell density, hexagonality, CV and CCT 4 weeks after surgery based on Insulin dependency.

	Group	
	IDDM(n=14)	**NIDDM (n=16)**
Endothelial density (cells/mm^2)- mean (SD)	1572.57+/-111.49	1616.38+/-193.8
Hexagonality (%)-mean (SD)	36.86+/-3.78	34.19+/-4.24
CV (%)-mean (SD)	45.50+/-4.86	44.81+/-3.37
CCT (µm)- mean (SD)	522+/-18.71	515.75+/-27.37

DISCUSSION

The groups with and without diabetes had significantly different endothelial cell densities, hexagonalities, CVs, and CCTs before surgery. There were significant differences between the groups with and without diabetes after surgery. Numerous studies on people with diabetes have revealed various abnormalities in the cornea, including increased permeability, increased CCT, decreased ECD, increased %CV, and decreased hexagonality [11]. Our results aligned with those of Choo *et al.* [12], who discovered, the mean (SD) endothelial cell density of people with type 2 diabetes was significantly lower than that of people in the Malaysian community without the illness. Consistent with our findings, Hugod et al. and Yang et al. reported higher levels of post-operative endothelial cell loss in individuals with diabetes than in non-diabetic patients [13,14]. According to Dhasmana *et al.* [15], compared to the control group, the diabetic group lost a noticeably larger percentage of endothelial cells following surgery. Four weeks following surgery, the study found a statistically significant difference in the mean hexagonality percentage between the diabetes group and the control group. Hugod *et al.* [13] reported similar results, showing that people with diabetes experienced a more significant hexagonality drop than those without the condition. More sensitive indicators of corneal endothelium stress are the coefficient of variation and polymorphism, represented by hexagonality and polymegathism, respectively. A more considerable hexagonality % decline four weeks after surgery in the study's diabetic group indicates a corneal endothelium repair response. The changes in hexagonality may lead to an unstable layer of corneal endothelial cells [13-16].

Patients with diabetes exhibited thicker central corneas than those without the illness, according to Storr-Paulsen et al. However, regulating blood sugar levels may impact these results [17]. Researchers Weston et al. found that diabetics have thicker corneas [18]. The two groups' percentage CVs in the pre-operative and post-operative phases differed considerably. Numerous investigations comparing groups with and without diabetes and between pre-operative and post-operative periods have found significant differences in CV and HC% [15,19-21]. Compared to fasting blood glucose, the HbA1c level may provide a more realistic picture of glycemic management in diabetics. However, no discernible correlation was seen between HbA1C levels and corneal density, CT, or CCT [22]. Saini and Mittal [23] discovered that corneal endothelial function was considerably reduced in patients with non-insulin-dependent diabetic diabetes (NIDDM). Nevertheless, they also discovered no connection between endothelial dysfunction and glycemia as determined by FBS. It has been shown that blood glucose levels and the duration of diabetes mellitus are related to the degree of corneal damage caused by cataract surgery [24,25]. Some of the study's limitations include the four-week follow-up period, the small sample size, and the smaller pupil diameters in diabetes patients, which may raise the risk of surgical problems. Despite these limitations, the findings are in line with previous studies.[26]

CONCLUSIONS

In diabetics, endothelial density, cardiovascular (CV), coronary artery (CCT), and hexagonality were statistically significantly different four weeks following surgery. The study found that the HbA1c levels of the diabetic group did not affect the ocular endothelial cells after cataract surgery. Diabetic individuals' corneal endothelium is more sensitive to stress during surgical procedures and has a lengthier healing period than the endothelium of people without diabetes. The findings suggest that after metabolic stress, diabetic corneal decompensation is more likely to occur. Therefore, it is essential to offer adequate glycemic control when doing cataract surgery on a diabetic patient. There is a notion that diabetics can reduce the stress associated with cataract surgery by protecting their corneal endothelium.

CONTRIBUTION OF AUTHORS

Research concept- M. Gitanjali, Samra Wahaj Fatima
Research design- Sowmya Chowdary, Samra Wahaj Fatima
Supervision- Sowmya Chowdary
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Data collection- Sowmya Chowdary
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Final approval- Sowmya Chowdary

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