DOI: https://doi.org/10.53350/pjmhs2023174264

ORIGINAL ARTICLE

Endothelial Cell Density before and after Phacoemulsification in patients with Diabetes Mellitus

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ABSTRACT

Introduction: Cataract is the leading cause of treatable blindness worldwide. Phacoemulsification with intraocular lens (IOL) implantation is the most common surgical procedure performed for the treatment of cataract. The diabetic cornea has decreased corneal endothelial cell density (CED) due to cell dysfunction and malfunctioning repair systems.

Objective: To compare the mean endothelial cell density before and after phacoemulsification in patients with diabetes mellitus.

Material and Methods: A total number of 30 patients who presented for cataract extraction were included. Data regarding patients age, gender, duration of diabetes mellitus and side of cataract was collected. One day before surgery, CED was measured in all patients using Specular Microscope. After 2 weeks of surgery, CED was measured again.

Results: Mean age of patients included in this study was 48.70±8.39 years. Mean duration of diabetes mellitus was 5.03±2.85 years. There were 16 (53.33%) males and 14 (46.67%) female patients. There were 15 (50.00%) patients with right eye and also 15 (50.00%) with left eye. On comparison of mean ECD between the Groups, the mean pre-operative ECD was 2753.05±126.91 Cells/mm2 and post-operative ECD was 2451.16±160.93 Cells/mm2, this difference was statistically significant with p value <0.0001.

Conclusion: Phacoemulsification is associated with significant decrease in endothelial cell density in diabetic patients presenting with cataract. The benefit of this study is that it adds to the existing body of literature on impact of phacoemulsification on endothelial cell density in diabetic patients which can help in the development of advanced surgical techniques and better post operative management in such patients.

Keywords: Endothelial cell density, phacoemulsification, diabetes mellitus.

INTRODUCTION

The most common preventable form of blindness in the world is cataract.[1] There are more than 190 million visually impaired people in the globe, 32 million of whom are blind.[2] Around 47% of all incidents of blindness globally are caused by cataracts.[3]

Phacoemulsification with intraocular lens (IOL) implantation is the most popular surgical method for treating cataracts and provides the benefits of less surgically caused astigmatism and a quicker, improved visual recovery.[4,5] Considering every possible benefit of phacoemulsification, the loss of corneal endothelial cells still causes a lot of concern, especially in patients whose endothelium has previously suffered damage.

Several studies have indicated an increased corneal vulnerability in diabetic subjects to intraocular surgical stress.[6] Reduced corneal endothelial cell density in the diabetic cornea is caused by cellular dysfunction and defective repair systems.[7] As a result of the corneal endothelium's limited capacity for regeneration, the cornea is susceptible to surgical injuries. Additionally, diabetic individuals who decide to have cataract surgery are often older and experience less CED as they age because fewer endothelial cells are present. Thus, it is advised to frequently assess the corneal endothelium before phacoemulsification, especially in individuals with diabetes.[8]

A study conducted by Khalid et al. evaluated the changes in corneal endothelial cells density (CED) after phacoemulsification and reported significant change in endothelial cells density; CED 2639.89±331.99 Cells/mm2 before phacoemulsification versus 2250.37±426.68 Cells/mm2 after 2 weeks of phacoemulsification in diabetic patients. The authors concluded that phacoemulsification has significantly negative effects on CED in diabetic patients.[9]

The aim of present study: is to determine the effect of phacoemulsification on CED in diabetic patients undergoing cataract surgery. Because corneal endothelial cells are responsible for maintaining the clarity of the cornea by actively removing the water and any disruption in endothelial balance may thus have a significant impact on the transparency of cornea. So, present study results will help us to determine the effect of phacoemulsification on CED in diabetic patient, if higher effect is found then it will create an alarm for ophthalmologists and will provoke them to look for a safer method of cataract management in diabetic patients.

Study Design: Pre & post study design.

Setting: Department of ophthalmology, Nishtar Hospital Multan.

Sample Size: The sample size for this study is 16 patients. However, we took 30 diabetic patients undergoing phacoemulsification. Sample size is calculated by taking Pre-treatment ECD 2639.89±331.99 Cells/mm2. And post-treatment ECD 2250.37±426.68 Cells/mm2.Power of the test 80% and level of significance (α) 5.0%.

The sample size is calculated by using STAT 15.0 software for calculation of sample size for two sample paired-means test.

Sampling Technique: Non-probability, consecutive sampling.

SAMPLE SELECTION:

Inclusion criteria:

- Patients of cataract as per operational definitions.
- Adult patients of age 30 years to 60 years.
- Known case of diabetes mellitus (Duration of diabetes mellitus ≥2 years).
- Both male and female patients.

Exclusion criteria:

- Patients having previous history of ocular trauma.
- Patients having previous history of intra-ocular surgery.
- Patients with bilateral cataract.

Operational definitions:

Cataract: Final diagnosis of cataract was made using slit-lamp examination. Patients with cataract density of grade 2 and grade 3 (as seen on slit-lamp images, see annexure- II) as determined by the Lens Opacity Classification System III and Axial Length (AL) between 23 and 25 mm (measured using ultrasound biometry) were labelled as having cataract.

Diabetes Mellitus: Patients taking anti-diabetic medication from atleast last 2 years were labelled as having diabetes mellitus.

Corneal Endothelial Cell Density (CED): A consultant ophthalmologist tested CED in all patients using a Topcon SP 3000P specular microscope (Topcon Corporation, Tokyo, Japan) system. A non-invasive photography technique called specular microscopy assesses the total number, size, and form of

endothelial cells. It was noted in cells/mm2.CED was measured one day before surgery and after 2 weeks of phacoemulsification.

Data Collection Procedure: After approval of synopsis from hospital ethical committee, a total number of 30 patients who presented for cataract extraction fulfilling the inclusion criteria of the study were selected after written informed consent. Data regarding patients age, gender, duration of diabetes mellitus and side of cataract was collected after inclusion in study. One day before surgery, CED was measured in all patients using Specular Microscope by consultant ophthalmologist having a minimum of three years post-fellowship experience. A single skilled surgeon performed the phacoemulsification cataract surgery on all patients using the same phaco machine. After 2 weeks of surgery, CED was measured again by different consultant ophthalmologist (unaware of the study hypothesis). All study relevant information was noted on a pre-designed.

The ophthalmologist uses the diagnostic techniques listed in Table 1 to assess cataracts.

Table 1: Diagnostic Techniques

Slit Lamp	Uses a microscope and slit beam of light to examine the lens, cataract density and other structures in the eye
Potential acuity meter	Measures the clarity of vision at different distances using an eye chart
B-scan ultrasound	Uses high-frequency sound waves to create a visual image of the lens and other structures in the eye. It helps to detect Retinal Detachment or any tumor in case of dense cataract
Glare testing and contrast sensitivity testing	Used to evaluate functional impact of glare or loss of contrast in cataracts

Data Analysis Procedure: Date analysis was carried out using SPSS version 23 Software. Qualitative variables such as gender and side of cataract were presented as frequency and percentage. Quantitative variables such as age, duration of diabetes mellitus, pre-op CED and post-op CED were provided as mean ± standard deviation (S.D.). The mean pre- and post-op CED values were compared using a paired sample t-test. Affect modifiers such as age, gender, duration of diabetes and side of cataract were controlled through stratification. Post-stratification paired sample t-test was applied again. P-value <0.05 was considered as significant difference.

RESULTS

Mean age of patients included in this study was 48.70±8.39 years. Minimum age was 30 years and maximum age was 60 years (Table 2).

Table 2. Descriptive statistics of age.

Age (Years)	
Mean	48.70
S.D.	8.39
Minimum	30
Maximum	60

Mean duration of diabetes mellitus was 5.03±2.85 years. Minimum duration was 02 years and maximum duration was 12 years (Table 3).

Table 3. Descriptive statistics of duration of diabetes mellitus.

Duration of Diabetes Mellitus (Years)	
Mean	5.03
S.D.	2.85
Minimum	02
Maximum	12

Mean pre-operative ECD was 2753.06±126.91 cells/mm2. Minimum pre-operative ECD was 2430 cells/mm2 and maximum was 2962.06 cells/mm2 (Table 4).

Table 4. Descriptive statistics of pre-operative Corneal Endothelial Cell Density (CED).

Corneal Endothelial Cell Density (cells/mm^2).	
Mean	2753.06
S.D.	126.91
Minimum	2430.00
Maximum	2962.06

Mean post-operative ECD was 2425.17±160.94 cells/mm2. Minimum post-operative ECD was 2150 cells/mm2 and maximum was 2650 cells/mm2(Table 5).

Table 5. Descriptive statistics of post-operative Corneal Endothelial Cell Density (CED).

Corneal Endothelial Cell Density (cells/mm^2).	
Mean	2425.17
S.D.	160.94
Minimum	2150
Maximum	2650

There were more male patients as compared to females. There were 16 (53.33%) males and 14 (46.67%) female patients. On frequency of side of cataract, there were 15 (50.00%) patients with right eye and also 15 (50.00%) with left eye .On comparison of mean ECD between the Groups, the mean pre-operative ECD was 2753.05±126.91 Cells/mm2 and post-operative ECD was 2451.16±160.93 Cells/mm2, this difference was statistically significant with p-value <0.0001 (Table 6).

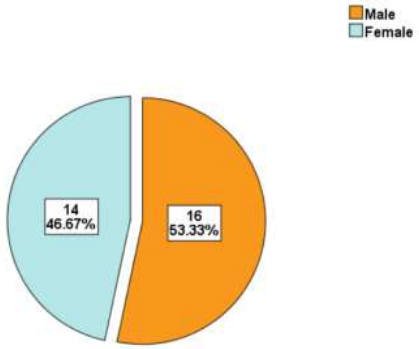

Figure 1 Frequency Of Gender

Table 6. Pre-operative and post-operative CED comparison.

	Pre-op CED	Post-op CED	P-value
Mean	2753.05	2425.16	<0.0001
S.D.	126.91	160.93	

Stratification of age was performed and no association was found of age with preoperative and post-operative CED. In patients having age 30-50 years, mean pre-operative CED 2793.35±131.09 cells/mm2 and in patients having age 51-60 years it was 2712.77±112.70 cells/mm2 with insignificant p-value of 0.082. In patients having age 30-50 years, mean post-operative CED 2480.33±161.29 cells/mm2 and in patients having age 51-60 years it was 2370.00±145.31 cells/mm2. With a p-value of 0.059, this difference was not statistically significant. (Table 7).

Table 7. Age stratification is used to study the relationship between age and both pre- and post-operative CED.

		Age Group		P-value
		30-50 Years	51-60 Years	
Pre-Operative CED	Mean	2793.35	2712.77	
	S.D.	131.09	112.70	0.082
Post-Operative CED	Mean	2480.33	2370.00	
	S.D.	161.29	145.31	0.059

Stratification of gender was also performed and no association was found of gender with pre-operative and post-operative CED. In male patients, mean pre-operative CED.2728.60±122.89 cells/mm2 and female patients, it was

2781.00±130.10 cells/mm2 with insignificant p-value of 0.267. In males, mean post-operative CED 2415.31±162.04 cells/mm2 and in females, it was 2436.43±165 cells/mm2. This difference was also statistically insignificant with p-value of 0.727 (Table 8).Stratification was also performed on the basis of diabetes mellitus and side of cataract. There was no association was found of these variable with pre-operative and postoperative CED.

Table 8. Stratification of gender to determine the association of gender with pre-operative CED and post- operative CED.

		Gender		P-value
		Male	Female	
Pre-Operative CED	Mean	2728.60	2781.00	
	S.D.	122.89	130.10	0.267
Post-Operative CED	Mean	2415.31	2436.43	
	S.D.	162.04	165.00	0.727

Table 9. Stratification of duration of diabetes mellitus to determine the association of duration of diabetes mellitus with pre-operative CED and post- operative CED.

		Duration of Diabetes Mellitus		P-value
		02-04 Years	05-12 Years	
Pre-Operative CED	Mean	2733.58	2772.54	
	S.D.	128.74	126.40	0.410
Post-Operative CED	Mean	2452.33	2398.00	
	S.D.	133.83	184.82	0.364

DISCUSSION

A quick and delicate surgical treatment, phacoemulsification with IOL insertion only requires a small incision site. It is the procedure that is most frequently used to cure cataracts globally and is perceived to be quite safe, despite the fact that the approach, expertise of the surgeon, and other patient factors all affect the outcome. The introduction of powerful ultrasonic energy phaco tips and other tools in a relatively very small space of the anterior chamber during the procedure makes corneal touch inevitable. This kind of interaction with the cornea mostly harms the corneal endothelial layer, which is made up of a film of hexagonal cells with crucial purposes like maintaining the clarity and integrity of the cornea using pump system. As corneal endothelium cells cannot regrow, their deficiency compromises the cornea's dehydration pump mechanism, causing hydration and clarity loss (compromised cornea).[11] Hence, CED loss continues to be a top concern for surgeons, particularly in elderly patients whose corneal endothelium is already damaged.

The condition of the corneal endothelium in diabetic patients has been the subject of numerous studies using the specular microscope, and most of them agree that these patients exhibit morphologically abnormal features in comparison to healthy controls, such as loss of hexagonality, reduced CED, a larger coefficient of variance, and an increased central corneal thickness (CCT).[12,13] Overall, the outcome is instability and susceptibility to a single slight surgical trauma. These characteristics have also been observed in diabetics taking medication for glycemic control. This suggests that diabetes mellitus may be an unavoidable risk factor for CED loss following phacoemulsification. Additional risk variables include years of age, shorter AL and AC depth, cataract intensity, corneal incision in terms of size, phacoemulsification duration, average ultrasonic power, lens fragment and IOL contact during installation, viscoelastic material used, and others. [6,9,14] We selected patients who were in the same age range (40–60 years), had a particular AL (23–25 mm) and cataract density (NO 2 and NO 3), and underwent phacoemulsification in a brief period of time (40 sec). Surgical factors were reduced by using a similar surgical technique, carried out by the same surgeon in each case while using the same phaco machine.[15] Research is being conducted to monitor CED loss in diabetic patients after small incision cataract operations in comparison to non-diabetic controls. Many studies have already shown that postoperative edema resolution and increased morphological and functional damage to diabetic corneas occur during surgery. Our results coincide with theirs.[16,17]

Hugod M. et al. noted that patients with diabetes had a lengthy recovery period from corneal edoema and significant CED destruction. The mean CED depletion was found to be 6.2% in the diabetic group and 1.4% in the control category after the researchers evaluated 30 patients with type 2 diabetes and 30 healthy subjects.[18] A study conducted by Khalid et al. evaluated the changes in corneal endothelial cells density (CED) after phacoemulsification and reported significant change in endothelial cells density; CED 2639.89±331.99 Cells/mm2 before phacoemulsification versus 2250.37±426.68 Cells/mm2 after 2 weeks of phacoemulsification in diabetic patients.[9] The authors concluded that phacoemulsification has significantly negative effects on CED in diabetic patients.

In this research, we tried to explore the impacts of numerous prospect variables that might affect the outcome. The study is the first of its series in Pakistan, and the findings support earlier research. It is advised to do additional studies of this type with larger sample sizes and more parameters. We believe that our study will add valuable information to the existing literature.

CONCLUSION

Phacoemulsification is associated with significant decrease in endothelial cell density in diabetic patients presenting with cataract. The benefit of this study is that it adds to the existing body of literature on impact of phacoemulsification on endothelial cell density in diabetic patients which can help in the development of advanced surgical techniques and better post operative management in such patients.

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