Section: Ophthalmology

Original Research Article

IMPACT OF PHACOEMULSIFICATION ON CORNEAL THICKNESS AND ENDOTHELIAL HEALTH IN DIABETIC VS NON-DIABETIC PATIENTS: A COMPARATIVE ANALYSIS

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Received *: 17/12/2024*
Received in revised form *: 10/02/2025*
Accepted *: 25/02/2025*

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DOI: 10.70034/ijmedph.2025.1.166

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (1); 894-897

ABSTRACT

Background: The objective of this study is to investigate the relationship between changes in corneal endothelial cells and central corneal thickness (CCT) after phacoemulsification surgery in both diabetic and non-diabetic individuals.

Material and Methods: This prospective study included a total of 80 patients, comprising 40 individuals with diabetes and 40 without, all of whom were undergoing phacoemulsification surgery. Endothelial cell count (ECC), hexagonality (HEX), and coefficient of variation (CV) were evaluated both before and after surgery through the use of specular microscopy. The statistical analysis focused on the relationships between these parameters and central corneal thickness (CCT).

Results: The findings indicate that diabetic patients demonstrated positive correlations between ECC and CCT ($r = 0.467$, $p = 0.10$) as well as HEX and CCT ($r = 0.389$, $p = 0.22$). In contrast, non-diabetic patients exhibited weaker correlations. The coefficient of variation revealed subtle positive trends in both groups.

Conclusion: corneas affected by diabetes exhibit increased vulnerability to endothelial stress after undergoing phacoemulsification. Specular microscopy serves as an essential instrument for preoperative assessment, aimed at enhancing surgical results, especially in individuals with diabetes.

Keywords: Phacoemulsification, Corneal Endothelium, Central Corneal Thickness.

INTRODUCTION

The corneal endothelium is crucial for preserving the clarity of the cornea, as it actively manages hydration via a sophisticated pump and barrier system. Nonetheless, surgical procedures like cataract extraction through phacoemulsification can place considerable strain on the corneal endothelium, resulting in morphological alterations and possible functional impairment. The implications of these effects are particularly alarming for individuals with diabetes mellitus, as they are more susceptible to endothelial cell dysfunction stemming from systemic microvascular complications.[1,2] Changes in corneal endothelial cells following surgery, including decreased cell density and heightened polymegathism, can negatively impact central corneal thickness (CCT), which is frequently utilized as an indirect indicator of endothelial health.[3,4]

Corneas affected by diabetes display unique characteristics, such as lower endothelial cell density (ECD), impaired pump function, and slower healing after surgical procedures. These factors increase the risk of significant endothelial damage during phacoemulsification. Grasping the connection between changes in endothelial cells and

postoperative central corneal thickness (CCT) is essential for enhancing surgical results in this at-risk group. Specular microscopy stands out as a non-invasive imaging technique that plays a crucial role in evaluating endothelial morphology. It allows for the quantification of changes in endothelial cell density (ECD), pleomorphism, and polymegathism both before and after surgical procedures.[7,8]

This research focuses on employing specular microscopy to investigate alterations in corneal endothelial cell properties after phacoemulsification in individuals with diabetes, while also examining the relationship between these changes and postoperative central corneal thickness. Through the examination of these parameters, we aim to deepen our comprehension of how diabetes influences corneal surgical results and aid in refining perioperative management approaches for patients with diabetes.[9,10]

MATERIALS AND METHODS

This study was designed as a prospective, selective, non-randomized, and interventional investigation involving 80 patients over the age of 50, all of whom had controlled diabetes and showed no signs of diabetic retinopathy (DR). Participants presented with notably complex cataracts, including cortical, nuclear (NSI, NSII, NSIII), or posterior subcapsular (PSCI, PSCII) types, which significantly interfered with their daily activities. In contrast, the non-diabetic group comprised individuals whose cataracts also affected daily functions but maintained a visual acuity superior to hand movement (HM). Informed written consent was secured from either the patients or their relatives.

The exclusion criteria encompassed mature cataracts that led to a visual acuity of hand movement, uncontrolled diabetes accompanied by diabetic retinopathy, prior ocular surgeries, corneal pathologies like Fuchs dystrophy, uveitis, glaucoma, and systemic conditions impacting the corneal endothelium. It also includes endocrine disorders, infections, autoimmune diseases, genetic disorders, and complications arising from earlier phacoemulsification procedures. Individuals younger than 50 years were also omitted from the study.

In this study, participants were categorized into two distinct groups: Group 1 comprised diabetic patients presenting with complex cataracts who successfully underwent phacoemulsification, while Group 2 included non-diabetic individuals with senile cataracts who experienced uncomplicated phacoemulsification procedures. Every participant engaged in a thorough evaluation that encompassed a review of their medical history, eye examinations, diagnostic tests, and laboratory assessments. These included fasting blood sugar (FBS), postprandial blood glucose (PPBG), glycated hemoglobin (HbA1c), renal function tests, complete blood count (CBC), and electrocardiograms (ECG). Further consultations were carried out to eliminate the possibility of infections or other health issues.

The investigations involved utilizing an IOL Master, A-scan biometry, manual keratometry, and B-scan ultrasonography specifically for cases presenting with dense cataracts. Preoperative assessments involved the use of specular microscopy to determine endothelial cell count (ECC), hexagonality percentage, central corneal thickness (CCT), and coefficient of variation (CV). Corneal swabs were collected prior to surgery for the purpose of culture and sensitivity testing.

Phacoemulsification was conducted with the procedure supported by both peribulbar and topical anesthesia. All patients were operated by the same surgeons by using phaco chop technique to exclude any surgeon related bias.

The follow-up process involved measuring uncorrected visual acuity (UCVA) during the initial week until the corneal edema subsided. This was succeeded by evaluations of best-corrected visual acuity (BCVA) at one- and three-months post-procedure. The postoperative assessment encompassed various parameters such as the grading of corneal edema, evaluation of wound status, measurement of anterior chamber depth, assessment of pupil regularity, observation of the red reflex, stability of the intraocular lens (IOL), and intraocular pressure (IOP) recorded using a Goldmann applanation tonometer. Fundus examinations and specular microscopy assessments were conducted at one-month and three-month intervals. Further follow ups were arranged to address any potential complications.

The statistical analysis was performed utilizing SPSS version 26, developed by IBM in Chicago, Illinois, USA. In this study, researchers employed the unpaired Student's t-test to compare quantitative variables across different groups. For qualitative variables, the analysis was conducted using either the Chi-square test or Fisher's exact test, depending on the data characteristics. A two-tailed P-value of less than 0.05 was deemed statistically significant. Correlations were evaluated through the application of Pearson or Spearman methods, tailored to the distribution characteristics of the variables involved.

RESULTS

The demographic and medical history data of the study participants are outlined in Table 1, which categorizes them into two distinct groups: diabetic and non-diabetic patients, with each group comprising 40 individuals. The average age of participants in the diabetic group was 62.85 years, compared to 63.6 years in the non-diabetic group, revealing no significant difference between the two (p=0.702). The distribution of eye involvement was comparable between both groups, with no significant difference observed (right vs. left,

p=1.000). The findings confirmed that diabetes was observed in all participants of the diabetic group, while it was absent in the non-diabetic group, with a statistically significant result (p<0.001). In the diabetic cohort, there was a higher prevalence of hypertension and cardiac issues; however, these findings did not reach statistical significance. There were no notable differences observed between the groups concerning other conditions, such as bronchial asthma and deep vein thrombosis (DVT). This data emphasizes the similarities between the groups, while also drawing attention to the systemic comorbidities that are prevalent among diabetic patients.

The findings presented in Table 2 illustrate the levels of cataract density and corneal edema observed in both diabetic and non-diabetic populations. The distribution of cataract density types, such as cortical, nuclear (NSI, NSII, NSIII), and posterior subcapsular (PSCI, PSCII), exhibited notable variations. Interestingly, the occurrence of nuclear cataracts (NIII) and posterior subcapsular cataracts (PSCII) was markedly higher in individuals with diabetes, with statistical significance noted (p=0.01 for both). In the assessment of postoperative corneal edema at one and three months, there was an observable trend indicating a greater resolution in the non-diabetic group; however, this difference did not achieve statistical significance. The results indicate a potential difference in cataract density and the recovery of the cornea after surgery between diabetic and non-diabetic individuals, highlighting the need for additional research in this area.

Table 3 illustrates the beneficial relationship between changes in the endothelium and central corneal thickness (CCT) observed in both diabetic and non-diabetic populations. Among individuals with diabetes, the endothelial cell count (ECC) showed a moderate positive correlation with central corneal thickness (CCT) (r = 0.467, p = 0.10). This suggests a potential trend toward a direct relationship, although it did not reach statistical significance. Hexagonality (HEX) demonstrated a moderate positive correlation (r = 0.389, p = 0.220), whereas the coefficient of variation (CV) revealed a weak positive correlation (r = 0.152, p = 0.582). Among individuals without diabetes, a slight positive correlation was observed between ECC and CCT, with a correlation coefficient of r = 0.288 and a p-value of 0.452. HEX showed a notable positive correlation (r = 0.345, p = 0.256), while CV exhibited a moderate positive correlation (r = 0.289, p = 0.310). The results indicate a positive correlation between endothelial changes and CCT in both groups, albeit with differing levels of intensity. This observation suggests an enhanced ability of endothelial cells to preserve or adapt, thereby sustaining corneal thickness in both diabetic and non-diabetic individuals.

Table 1: Medical history and Demographic Data of the studied patients

Variable	Diabetic Group (n=40)	Non-diabetic Group (n=40)	P-value
Age	62.85	63.6	0.618
Gender			
Male	8 (20.00%)	18 (45.00%)	0.521
Female	32 (80.00%)	22 (55.00%)	
Which Eye			
Right	18 (45.00%)	18 (45.00%)	1
Left	22 (55.00%)	22 (55.00%)	
Medical History			
DM	40 (100.00%)	0 (0.00%)	<0.001*
HTN	22 (55.00%)	12 (30.00%)	0.20
Cardiac	10 (25.00%)	10 (25.00%)	1
Bronchial Asthma	4 (10.00%)	2 (5.00%)	0.429
DVT	0 (0.00%)	2 (5.00%)	0.201

Table 2: Degree of corneal edema and cataract density

Variable		Diabetic Group (n=40)	Non-diabetic Group (n=40)	P-value
Degree of cataract density	Cortical	16 (40.00%)	18 (45.00%)	0.68
	NI	12 (30.00%)	12 (30.00%)	0.9
	NII	30 (75.00%)	22 (55.00%)	0.21
	NIII	10 (25.00%)	0 (0.00%)	0.01
	PSCI	16 (40.00%)	10 (25.00%)	0.35
	PSCII	12 (30.00%)	2 (5.00%)	0.01
Corneal Edema				
Post Operation First Month	No	12 (30.00%)	22 (55.00%)	0.15
	Mild	14 (35.00%)	16 (40.00%)	
	Moderate	8 (20.00%)	4 (10.00%)	
Post Operation third Months	Corneal Edema - Post Operation Third Month - No	28 (70.00%)	36 (90.00%)	0.12
	Corneal Edema - Post Operation Third Month - Mild	12 (30.00%)	4 (10.00%)	
	Corneal Edema - Post Operation Third Month - Moderate	0 (0.00%)	0 (0.00%)	

Table 3: Correlation among endothelial alteration and CCT in both groups

	Diabetic Group		Non-diabetic Group	
Variable	**r**	**P-value**	**r**	**P-value**
ECC Pre-operation	0.467	0.1	0.288	0.452
HEX Pre-operation	0.389	0.22	0.345	0.256
CV Pre Operation	0.152	0.582	0.289	0.31

DISCUSSIONS

This research sought to explore the relationship between changes in the endothelium and central corneal thickness (CCT) after phacoemulsification in both diabetic and non-diabetic individuals. The findings highlighted clear differences in endothelial responses between the two groups, shedding light on how diabetes affects corneal health.

In individuals with diabetes, the endothelial cell count (ECC) exhibited a moderate positive correlation with central corneal thickness (CCT) ($r = 0.467$). This indicates that an increased ECC may play a role in preserving corneal thickness in the face of surgical stress. Nonetheless, this association did not achieve statistical significance ($p = 0.10$). Comparable results were noted for hexagonality (HEX), which showed a moderate positive correlation ($r = 0.389$, $p = 0.22$). Recent findings support earlier studies that show diabetic corneas suffer from impaired endothelial function as a result of ongoing metabolic stress. This condition results in disrupted hydration regulation and slower recovery times.[1,2]

Conversely, individuals without diabetes exhibited less robust associations between endothelial metrics and central corneal thickness. The results indicated a mild positive correlation for ECC ($r = 0.288$, $p = 0.452$), whereas HEX demonstrated a stronger positive association ($r = 0.345$, $p = 0.256$). The findings indicate that non-diabetic patients could face reduced endothelial stress following surgery, leading to a more consistent corneal thickness as time progresses. Earlier research has underscored the ability of non-diabetic corneas to preserve hydration and endothelial integrity following surgical procedures.[7,8]

The coefficient of variation (CV) revealed weak positive correlations in both groups, with non-diabetic patients exhibiting slightly stronger trends ($r = 0.289$ compared to $r = 0.152$). This observation could indicate differences in cell size and possible adaptive responses of the endothelium aimed at preserving corneal clarity.[3]

The results highlight the critical need for thorough preoperative evaluations of endothelial parameters, especially in diabetic individuals who face an elevated risk of endothelial dysfunction. Specular microscopy continues to serve as an essential instrument for tracking these alterations and informing perioperative management strategies.[4,9,10]

CONCLUSION

This research underscores the unique effects of phacoemulsification on the characteristics of corneal endothelial cells and central corneal thickness (CCT) in both diabetic and non-diabetic individuals. Diabetic patients showed moderate positive correlations between endothelial parameters and central corneal thickness (CCT), whereas the non-diabetic group displayed weaker but more consistent patterns. The results highlight the increased susceptibility of corneas in diabetic individuals to endothelial stress, emphasizing the necessity of conducting thorough preoperative endothelial evaluations, especially for those with diabetes. Specular microscopy serves as an essential instrument for assessing endothelial health and enhancing perioperative management, ultimately leading to improved surgical outcomes.

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