Al-Azhar International Medical Journal

Volume 4 | Issue 3 Article 21

2023

Evaluation of corneal endothelial cell changes in diabetic patients after phacoemulsification surgery

Eman Nagy Ahmed El-saied
Department of ophthalmology, faculty of medicine, alazhar university, Cairo, Egypt, emannagy9898@gmail.com

Heba Mahmoud Abd Elrahman
Assistant professor of Ophthalmology, Faculty of Medicine (for Girls), Alzahraa University Hospital

Nour El-din Abd El-Hamid Abd El-Halim
Assistant professor of ophthalmology, al-hussein university hospital

Ahmed Shafeek Abdullah
Professor of Ophthalmology, Faculty of Medicine (for Girls), Alzahraa University Hospital.

Nashwa Mohamed Lamey, professorof ophthalmology, faculty of medicine for girls, Alzahraa university hospital. Egypt

How to Cite This Article

El-saied, Eman Nagy Ahmed; Elrahman, Heba Mahmoud Abd; El-Halim, Nour El-din Abd El-Hamid Abd; Abdullah, Ahmed Shafeek; and Nashwa Mohamed Lamey, professorof ophthalmology, faculty of medicine for girls, Alzahraa university hospital. Egypt (2023) "Evaluation of corneal endothelial cell changes in diabetic patients after phacoemulsification surgery," *Al-Azhar International Medical Journal*: Vol. 4: Iss. 3, Article 21.
DOI: https://doi.org/10.58675/2682-339X.1720

ORIGINAL ARTICLE

Evaluation of Corneal Endothelial Cell Changes in Diabetic Patients After Phacoemulsification Surgery

Eman Nagy Ahmed El-saied [a,*], Heba Mahmoud Abd Elrahman [b], Nour El-din Abd El-Hamid Abd El-Halim [c], Ahmed Shafeek Abdullah [b]

[a] One Day Surgery Hospital, El-Basatin, Egypt
[b] Faculty of Medicine (for Girls), Alzahraa University Hospital, Egypt
[c] Faculty of Medicine (for Boys), Al-Hussein University Hospital, Egypt

Abstract

Background and aim: **The ultrasonic energy used in phacoemulsification surgery might cause damage to the corneal endothelium.**

This study used specular microscopy prior to and after phacoemulsification to assess corneal endothelial alterations in diabetes and non-diabetic eyes.

Patient and methods: **A total of 60 patients with cataract were scheduled for phacoemulsification. They were divided into group 1 (33 eyes of 30 non-diabetic patients) and group 2 (33 eyes of 30 controlled diabetic patients). Uncorrected and best-corrected visual acuity were evaluated. Anterior, posterior corneal surfaces, and anterior chamber depth were examined. Specular microscopy was used preoperatively and at 1 week, 1 month, and 3 months post-operatively.**

Results: **BCVA (best-corrected visual acuity), CCT (central corneal thickness), coefficient of variation (CV), and hexagonal cells (HEX%), the differences between both groups concerning preoperative and postoperative data were statistically not significant. No statistically significant difference in endothelial cell density (ECD) was found between both groups in preoperative values. While a statistically significant difference in ECD between both groups was found 1 month and 3 months following surgery.**

Conclusion: **Diabetic corneas experience metabolic stress and lesser capacity for preservation than non-diabetic corneas. In comparison to non-diabetic ones, it demonstrated a slower rate of recovery following phacoemulsification.**

Keywords: Central corneal thickness, Endothelial cell density, Diabetes mellitus, Phacoemulsification

1. Introduction

One of the most frequent factors leading to bilateral blindness is cataract. Nowadays, phacoemulsification is the method of choice for removing cataracts since it results in reduced astigmatism, quicker visual recovery, and less postoperative inflammation.[1]

Worldwide, diabetes mellitus (DM) affects more than 463 million people.[2] DM increases polymegathism, pleomorphism, and central corneal thickness (CCT) while decreasing endothelial cell density (ECD) and hexagonallity (HEX%).[3]

Because of intraoperative corneal manipulations, a portion of the endothelial cells are damaged throughout all surgical procedures that include entry into the anterior chamber. The neighboring cells swell and slide across to maintain endothelial cell continuity after endothelial cell loss (ECL), which is evident as a change in ECD and shape.[4]

During surgery, mild corneal endothelium injury might potentially cause a temporary rise in CCT. Pachymetry and specular microscopy can be used to clinically evaluate endothelial cell density, or CCT.[4] When compared to slit lamp biomicroscopy, the specular microscope is a very helpful noncontact

Accepted 5 February 2023.
Available online 12 June 2023

* Corresponding author at: Resident of Ophthalmology at One Day Surgery Hospital at El-Basatin, Egypt. Tel., 01060736353.
E-mail address: emannagy9898@gmail.com (E.N.A. El-saied).

https://doi.org/10.58675/2682-339X.1720

inquiry that images corneal endothelium at a very high magnification.[5]

2. Patients and methods

The current prospective comparative study involved 33 eyes from 30 non-diabetic patients (group 1) and 33 eyes from 30 controlled diabetic patients (group 2) who had phacoemulsification surgery and were hospitalized to the department of ophthalmology at the Al-Azhar University Hospitals between June 2021 and February 2022. The Al-Azhar University Ethical Board gave the study's procedure their approval. All patients received signed informed permission after being informed about the operation.

Inclusion criteria were patients with significant cataract, ages between 40 and 60, preoperative anterior chamber depth (ACD) and ECD were 2.5 mm, and 1500 cells/mm^2 and no history of ocular surgeries.

Exclusion criteria were age under 40, pseudoexfoliation syndrome, corneal disorder, past ocular injury, or intraocular inflammation.

All patients got a thorough medical history and ophthalmological evaluation, which included estimating intraocular pressure (IOP) by Goldmann applanation tonometry (made in Japan), performing uncorrected and best-corrected visual acuity (BCVA), and manifest refraction. Intraocular lens Master (Topcon ALADDIN HW2.0) calculated the IOL power, ACD, and axial length. Preoperatively, one month after surgery, and three months later, ECD, CCT, CV, and HEX% were examined using a noncontact specular microscope (Topcon SP-1P, produced in Japan). Every patient had three readings during each evaluation. Preoperatively, one day, one week, one month, and three months after surgery, all patients were examined. To eliminate any surgeon-related prejudice, the same surgeon operated on every patient.

The phacoemulsification apparatus was used on all patients during similar procedures employing the phaco-chop technique. One hour before to surgery, tropicamide 1% and cyclopentolate 1% eye drops were used, one drop every 15 min, to dilate the pupil. Under local anaesthetic, cataract surgery was carried out, a sharp keratome was used to make an anterior limbal incision, micro-vitreoretinal surgery (MVR) was used to create two side ports, viscoelastic material (2% hydroxypropyl methyl cellulose) was used to create the anterior chamber, after performing an anterior continuous circula curvilinear capsulorhexis, nuclear fragments were phacoemulsified after hydrodissection and hydrodelineation, following bimanual irrigation and aspiration of any remaining cortical matter, a foldable, single-piece IOL is implanted in the capsular bag, followed by hydration of wound. No stitches were used.

Topical prednisolone acetate 1% eye drops 'Optipred 5 ml, Jamjoom Pharmaceuticals Co.' was given as part of post-operative regimen every two hours for one week before being gradually weaned off over the course of six weeks. Topical gatifloxacin 0.3% eye drops every two awaken hours for 1 week then 4 times/day for 2 weeks, combination of 'Dexatobrin 5 gm eye ointment with tobramycin 3% and dexamethasone phosphate 0.1% once before bedtime for a week, ciprofloxacin 500 mg tablet 'Ciprofar 500 tab' per 12 h for 5 days when needed.

2.1. Statistical analysis

Chi-square and independent *t*-test are used to compare two groups. Every item of data was presented as mean and standard deviation. All data was considered not significant at P value > 0.05, significant at P value < 0.05 and highly significant at P value < 0.01.

3. Results

No significant variation was found between group regarding age and sex (Table 1).

In term of BCVA, an increase in it was found in both groups after surgery and no statistically significant changes between both groups regarding preoperative and post-operative BCVA (P value > 0.05) (Table 2).

Table 1. Demographic data of both groups.

	Non diabetic group Number = 33	Diabetic group Number = 33	Test value	P value	Sig.
Age (years)					
Mean ± SD	54.13 ± 6.66	56.00 ± 4.22	−1.296[b]	0.200	NS
Range	40–60	43–60			
Sex					
Female	21 (70.0%)	19 (63.3%)	0.300[a]	0.584	NS
Male	9 (30.0%)	11 (36.7%)			

P value > 0.05: Nonsignificant.
[a] Chi-square test.
[b] Independent *t*-test.

Table 2. Changes in BCVA between studied groups (Log Mar).

BCVA (Log Mar)	Non diabetic group Number = 33	Diabetic group Number = 33	Test value	*P* value	Sig.
Preoperative					
Mean ± SD	0.80 ± 0.33	0.77 ± 0.22	0.436[a]	0.664	NS
Range	0.3–1.78	0.48–1.48			
after 1 week					
Mean ± SD	0.43 ± 0.22	0.43 ± 0.21	−0.026[a]	0.979	NS
Range	0.18–1	0.18–1			
after 1 month					
Mean ± SD	0.37 ± 0.19	0.39 ± 0.21	−0.241[a]	0.810	NS
Range	0–0.78	0.18–1			
after 3 months					
Mean ± SD	0.28 ± 0.22	0.28 ± 0.23	−0.025[a]	0.980	NS
Range	0–0.78	0–1			

P value > 0.05: Nonsignificant.
[a] Independent *t*-test.

Table 3. Changes in CCT between studied groups.

CCT (μm)	Non diabetic group Number = 33	Diabetic group Number = 33	Test value	*P* value	Sig.
Preoperative					
Mean ± SD	523.36 ± 28.20	525.58 ± 28.87	−0.315[a]	0.754	NS
Range	472–589	456–621			
after 1 month					
Mean ± SD	537.83 ± 27.59	543.12 ± 27.03	−0.768[a]	0.445	NS
Range	487–601	488–636			
after 3 months					
Mean ± SD	527.18 ± 7.21	530.48 ± 25.34	−0.510[a]	0.612	NS
Range	476–590	480–621			

P value > 0.05: Nonsignificant.
[a] : Independent *t*-test.

One month following surgery, both groups experienced a rise in CCT, which then decreased to levels close to baseline three months later. For both groups' preoperative and postoperative data, no statistically significant variations in CCT (*P* value > 0.05) (Table 3).

Following surgery, there was a decrease in ECD in both groups. Preoperative ECD between the two groups did not change significantly. One month after surgery, there was an ECD difference between the two groups that was statistically significant (*P* value = 0.016). Three months following surgery, there was a highly statistically significant difference variation between the two groups' ECD levels. (*P* value < 0.01) (Table 4).

After surgery, CV increased in both groups. Regarding preoperative and postoperative data, no statistically significant differences in CV between two groups (*P* value > 0.05) (Table 5).

Table 4. Changes in ECD between studied groups.

ECD (c/mm^2)	Non diabetic group Number = 33	Diabetic group Number = 33	Test value	*P* value	Sig.
Preoperative					
Mean ± SD	2922.18 ± 417.61	2776.73 ± 360.21	1.515[a]	0.135	NS
Range	1780–3877	2035–3519			
after 1 month					
Mean ± SD	2826.69 ± 400.42	2589.15 ± 372.81	2.476[a]	0.016	S
Range	1700–3555	1865–3280			
after 3 months					
Mean ± SD	2756.73 ± 408.92	2339.73 ± 384.20	4.269[a]	0.000	HS
Range	1620–3500	1690–3140			

P value > 0.05: Nonsignificant.
P value < 0.05: Significant.
P value < 0.01: Highly significant.
[a] Independent *t*-test.

Table 5. CV changes between studied groups.

CV (%)	Non diabetic group Number = 33	Diabetic group Number = 33	Test value	*P* value	Sig.
Preoperative					
Mean ± SD	35.12 ± 3.62	35.70 ± 8.79	−0.348[a]	0.729	NS
Range	29–47	3–70			
after 1 month					
Mean ± SD	36.09 ± 3.74	37.94 ± 6.67	−1.370[a]	0.175	NS
Range	28–45	26–70			
after 3 months					
Mean ± SD	36.97 ± 3.64	38.64 ± 6.66	−1.262[a]	0.211	NS
Range	29–45	26–70			

P value > 0.05: Nonsignificant.
[a] Independent *t*-test.

After surgery, HEX% decreased in both groups. Preoperative and postoperative data showed no statistically significant differences in HEX% between the two groups. (*P* value > 0.05) (Table 6).

4. Discussion

Corneal endothelium is a necessary factor for keeping appropriate thickness of cornea, transparency, and hydration. Because it only has one hexagonal-shaped cell layer and lacks the ability to divide through mitosis, any change in the endothelial cell count is primarily compensated through mobilization and cell expansion.[6] The most effective method for treating cataract is called phacoemulsification, which also has little side effects while enhancing visual acuity. Despite the possible benefits of phacoemulsification, corneal ECL can happen as a result of damage from ultrasonic energy.[7]

Our research used specular microscopy before and after phacoemulsification to assess corneal endothelial cell alterations in diabetic and non-diabetic cases. 30 non-diabetic individuals made up group one of this study, and 30 controlled diabetic patients with cataract made up group two.

In Our study, no statistically significant change between both groups concerning age and sex. **Dandaliya *et al.*,** reported the same results.[8]

In our study, insignificant alteration in BCVA before and after operation between the two groups was found. Our findings are consistent with those of **Jahan *et al.*,** who observed similar results.[9] While, **Saliem** documented significant differences in BCVA among both groups 1 month and 6 months after surgery.[10]

Regarding our result about CCT, no statistically significant change between both groups was found in the preoperative and post-operative period. **Fernández-Muñoz *et al.*,** were in accordance with our result.[11] In contrast, **Abdelhalem *et al.*,** reported significant difference in CCT among both groups following phacoemulsification.[12]

According to earlier research, CCT increased much 1 day and 1 week following surgery before gradually declining for at least 3 months.[13] This reveals that the adverse effects of diabetes metabolic stress on corneal thickness include endothelial pump suppression, elevated osmolality of cell, and enhanced permeability of endothelium.[14] The reduction in CCT values one week and one month following operation was caused by the fact that corneal edema and inflammation decline together, however CCT did not return to baseline levels even after three months. The alterations in morphology may be greater in the periphery and this was not noticed in the method utilized in prior studies, but corneal endothelium that was photographed belonged to the centre cornea.[15]

Table 6. HEX differences between both groups.

HEX (%)	Non diabetic group Number = 33	Diabetic group Number = 33	Test value	*P* value	Sig.
Preoperative					
Mean ± SD	34.03 ± 6.33	32.85 ± 6.19	0.767[a]	0.446	NS
Range	17–44	16–49			
after 1 month					
Mean ± SD	29.44 ± 6.05	27.09 ± 7.42	1.395[a]	0.168	NS
Range	15–38	12–48			
after 3 months					
Mean ± SD	28.61 ± 6.39	26.21 ± 7.08	1.441[a]	0.154	NS
Range	15–40	15–48			

P value > 0.05: Nonsignificant.
[a] Independent *t*-test.

Regarding the result about the ECD, no significant difference was found between both groups preoperatively. While, concerning the postoperative data about ECD, we detected a statistically significant change among both groups. Our results match with **Dandaliya** ***et al.***, who documented similar results about postoperative ECD.[8] On the other hand, no statistically significant difference after surgery reported by **Fernández-Muñoz** ***et al.***[11]

Following phacoemulsification, endothelial cell count is utilized to assess the condition of the cornea. Corneal endothelial decreases after surgery, and this effect is more pronounced in diabetes patients due to poor repairing process. When endothelial cells are lost, the remaining cells quickly grow in an effort to fill the gap, which results in a temporary rise in cell size and a fall in HEX%. This raising in cell size is accompanied by CV increase.[14] Numerous factors related to the changed value of Endothelial cell loss between researches: methods of operation, time of examination of cornea, and patient groups. According to the majority of earlier researches, diabetes patients' postoperative ECL is statistically different from that of non-diabetic individuals.[4]

After surgery, CV increased in both groups. Regarding preoperative and postoperative data, no statistically significant differences in CV between two groups (P value > 0.05). **Erfan** ***et al.***, were in accordance to our results.[14] While, **Chaurasia** ***et al.***, reported significant findings in CV among both groups after surgery.[16]

Any rise in CV, which measures the homogeneity of endothelial cell size, denotes significant levels of pleomorphism. It shows that the endothelium's post-operative repair and healing mechanisms are functioning. A smaller decrease in CV following surgery is indication of a slower and less effective healing recovery response in corneal endothelium of diabetic patients.[17]

Regarding preoperative and postoperative data of HEX %, no statistically significant differences were found between two groups. Our results match with **Erfan** ***et al.***, were in accordance to our results.[14] While, **Chaurasia** ***et al.***, reported significant findings in HEX % among both groups after surgery.[16]

4.1. Limitations

The study's limits were its small sample size and brief period of follow-up.

4.2. Conclusion

We found that the corneal endothelium of diabetic patients recovered more slowly after surgery and was more vulnerable to surgical trauma. It is crucial to choose the right time and have a decent glycemic condition while doing phacoemulsification on diabetic patients as it affects corneal endothelium. In order to reduce surgical trauma, it is also advised that corneal endothelium needs special attention and safeguards during phacoemulsification.

4.3. Recommendation

For both diabetic and non-diabetic cases who have undergone phacoemulsification, we advise performing corneal examination using specular microscopy.

Authors' contributions

All authors had equal role in design, work, statistical analysis and manuscript writing. All authors have approved the final article work.

Conflicts of interest

The authors declare that they have no conflict of interest.

References

1. Khan A, Kose S, Jharwal M, et al. Comparison of corneal endothelial cell counts in patients with controlled DM (Type 2) and non-diabetics after phacoemulsification and IOL implantation. *Int Multispec J Health*. 2016;2:14−22.
2. Saeedi P, Petersohn I, Paraskevi Salpea P, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045. In: *Results from the Int Diabetes Federation Diabetes Atlas*. ninth ed. *Diabetes Res Clin Pract.* 157. 2019, 107843.
3. Shenoy R, Khandekar R, Bialasiewicz A, et al. Corneal endothelium in diabetic patients: a historical cohort study. *Eur J Ophthalmol*. 2009;19:369−375.
4. Mathew PT, David S, Thomas N. ECL and CCT in patients with and without DM after manual small incision cataract surgery. *Cornea*. 2011;30:424−428.
5. Kanski J, Bowling B, Nischal K. *'Cornea'. Clinical Ophthalmology: A Systematic Approach.* eighth ed. Edinburgh: Elsevier/Saunders; 2015:168−172.
6. Tang Y, Chen X, Zhang X, et al. 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.
7. Mohammadi SF, Hashemi H, Mazouri A, et al. Outcomes of cataract surgery at a referral center. *J Ophthalmic Vis Res*. 2015;10:250−256.
8. Dandaliya I, Bedi DK, Nainiwal SK. Evaluation of corneal endothelial cell changes in diabetic patients before and after phacoemulsification surgery: a comparative study. *Indian J Clin Exp Ophthalmol*. 2018;4:458−464.
9. Jahan I, Rahman MM. Corneal endothelial cell change after phacoemulsification: a comparison between diabetic and non-diabetic patient. *Ann Int Med Dent Res*. 2021;7:56−67.
10. Saliem EA. Corneal endothelial cells changes after phacoemulsification in diabetic patients. *Egypt J Hosp Med*. 2019;74:1−9.

11. Fernández-Muñoz E, Zamora-Ortiz R, Gonzalez-Salinas R. ECD changes in diabetic and nondiabetic eyes undergoing phacoemulsification employing phaco-chop technique. *Int Ophthalmol*. 2019;39:1735–1741.
12. Abdelhalem R, Saif MYS, Mohamed S. CCT before and after phacoemulsification in non-diabetic and diabetic patients without retinopathy. *NILES J Geriatr Gerontol (Geriatric Ophthalmol)*. 2020;3:15–22.
13. Wang B, Li JX, Wang YL, et al. Clinical effect analysis of phacoemulsification on cataract patients with DM. *Int Eye Sci*. 2013;13:1163–1166.
14. Erfan MB, Khalil HE, Haroun HE, et al. Evaluation of the corneal thickness and endothelial changes following uncomplicated Phacoemulsification in diabetic and non-diabetic patients by pentacam and specular microscopy. *Egypt J Hosp Med*. 2020;79:489–496.
15. Ganesan N, Srinivasan R, Babu K, et al. Risk factors for endothelial cell damage in diabetics after phacoemulsification. *Oman J Ophthalmol*. 2019;12:94–98.
16. Chaurasia RK, Khasnavis A, Mittal J. Comparison of corneal endothelial changes following phacoemulsification in diabetic and non-diabetic patients. *Indian J Ophthalmol*. 2022;70: 1208–1213.
17. Sahu P, Das G, Agrawal S, et al. Comparative evaluation of corneal endothelium in diabetic patients undergoing phacoemulsification. *Middle East Afr J Ophthalmol*. 2017;24:195–201.