Diabetes Mellitus in the eyes of Cataract Patients Undergoing Phacoemulsification

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ABSTRACT

Cataract lenses are removed from inside the eye through the use of ultrasonic energy and an irrigation/aspiration process, which is then followed by intraocular lens implantation (IOL). The ultrasonic energy used to shave cataracts is currently so concentrated on the cataract itself, but it is still possible that this energy has a different effect on the eye tissue during the phacoemulsification process. Phacoemulsification in diabetic patients is quite challenging. We need to pay attention to these combined diseases and their consequences in order to preserve the delicate tissues and structures of the eye and ensure its function until the future.

Keywords: Diabetes Mellitus, Cataract, Phacoemulsification, Examination

INTRODUCTION

The global prevalence of diabetes mellitus makes it a leading cause of blindness and other visual impairments. About 463 million people (those between the ages of 20 and 79) already have diabetes, and it is projected to increase to 700 million by 2045, according to the International Diabetes Federation. Death, kidney failure, heart disease, stroke, blindness, and leg amputation are all linked to poorly managed diabetes (Alabdulwahhab, 2022). Diabetic retinopathy, diabetic macular edema, cataracts, and glaucoma are all part of diabetic eye disease, the most common consequence of diabetes (Sarki et al., 2020). Diabetic retinopathy is considered a serious condition and often develops as a long-lasting complication of diabetes. Early detection is very important, as it can lead to direct vision loss if not treated with appropriate and effective treatment (Medina et al., 2024) (Senapati et al., 2024). In addition to diabetic retinopathy, another major complication is diabetic macular edema (DME). Thickening of the retina around or affecting the fovea due to the accumulation of aberrant fluid in the macula in a diabetic state is a hallmark of diabetic macular edema (Zhang et al., 2022). The estimated worldwide prevalence among people with diabetes from 2015 to 2019 was 4.6%, making it the leading cause of central vision loss in adults with diabetes (Gurung et al., 2020). Lens cloudiness (cataracts) is a complication of diabetes mellitus, which can affect any part of

the eye. Researchers have shown that the risk of cataracts is two to five times higher in people with diabetes than in the general population. The prevalence of cataracts in diabetic patients varies, but it is estimated that about 60% of individuals with diabetes will develop cataracts by the age of 65 (Martínez et al., 2021). Phacoemulsification and implantation of intraocular lenses are the most common surgical procedures used to treat cataracts. This procedure causes effects after it is performed, which can lead to damage to the corneal endothelium, a layer of hexagonal cells essential for maintaining corneal clarity, and also affects the macula and RNFL (retinal nerve fiber layer). This study aims to evaluate the effects of phacoemulsification on diabetic patients.

METHOD

In this study, we used a literature review method. The search was conducted using PubMed, with article selection based on the keywords “Phacoemulsification” and “Diabetes Mellitus” from the past five years. After several rounds of screening, 10 relevant articles were ultimately selected according to our interests.

RESULT

Brief summary results of the main findings

Table 1. Synthesis

Not	Journal Title	Author and Year	Research Objectives	Method	Key Results	Conclusion
1	Meta-analysis of corneal endothelial changes after	Yang et al. (2023)	Evaluate the effect of phacoemulsification on the corneal endothelium between diabetic	Meta-analysis of 13 studies on 1,744 eyes.	Diabetic patients show greater endothelial corneal damage and slower recovery.	Phacoemulsification affects the corneal endothelium of diabetic patients more.

	phaco emuls ificati on in diabet ic and non- diabet ic patien ts		and non-diabetic patients.			
2	Corneal Endothelial Changes after Phacoemuls ification in Diabetic and Non-diabetic patients	Ghany et al. (2024)	Comparing post-phacoemul sification corneal endotheliu m alterations in non-diabetic patients to type 2 DM patients using specular microscop y.	A prospective cross-sectional study was carried out on 40 patients who had cataracts following phacoemuls ification.	No statistically significant difference was observed in endothelial cell density (ECD) between the two groups, both before and after phacoemulsi fication.	There were significant endothelial cell density changes in DM patients after phacoemuls ification compared with non-diabetic patients.
3	Evaluation of Macular Thickness Changes	Segura et al. (2022)	To analyze changes in macular thickness	A prospective study including a	The study found a similar increase in	Macular thickness increases for up to six

	after Uncomplicated Phacoemulsification Surgery in Healthy Subjects and Diabetic Patients without Retinopathy by Spectral Domain OCT		after uncomplicated phacoemulsification surgery in non-diabetic subjects and DM patients without DR lesions, and to determine if DM increases the risks associated with these changes.	consecutive cohort of 36 DM patients without DR and 34 non-diabetic subjects diagnosed with cataract.	macular thickness and volume up to six months after cataract surgery in both diabetics without DR and non-diabetics.	months after phacoemulsification both diabetic patients without diabetic retinopathy and non-diabetic individuals, with no significant differences between the groups.
4	Comparison of corneal endothelial changes after phacoemulsification in diabetic and non-	Chaurasia et al. (2022)	Assess corneal endothelial changes after phacoemulsification in diabetic and non-	A prospective study in 200 patients.	Diabetic patients had greater negative changes in corneal endothelium and visual acuity than	Phacoemulsification has a greater impact on diabetic patients, potentially affecting visual outcomes.

	diabetic patients		diabetic patients.		non-diabetic patients.	
5	Comparison of corneal changes after phacoemulsification in diabetic and nondiabetic eyes	Elminshawy et al. (2021)	To evaluate and compare changes in the pre-corneal tear film, corneal surfaces, endothelial cells, and central corneal thickness (CCT) in diabetic and healthy patients before and after uncomplicated phacoemulsification.	This study included 40 eyes of 40 patients and specular microscopy were done preoperatively and at 1 week, 1 month, and 3 months postoperatively.	Significant differences were observed between preoperative and postoperative periods in both groups for BCVA, TBUT, CCT, ECD, coefficient of variation, and hexagonal cells.	Significant changes in BCVA, TBUT, central corneal thickness, and endothelial cell density occurred after phacoemulsification in both diabetic and healthy groups, with a notable delay in CCT recovery for diabetic individuals compared to healthy ones one month post-surgery.

6	Comparative study of effect of phacoemulsification on central macular thickness in diabetic and nondiabetic patients assessed with spectral domain optical coherence tomography	Hasan et al. (2023)	To evaluate how uncomplicated phacoemulsification affects central macular thickness (CMT) in diabetic and non-diabetic patients, using spectral domain OCT.	This prospective cohort study from January 2018 to June 2019, assessed 90 diabetic and 95 non-diabetic patients undergoing phacoemulsification.	The study found that macular thickness peaked at 6 weeks post-surgery, especially in diabetics but equalized by 12 weeks with no clinically significant difference.	Phacoemulsification with lens implantation may cause subclinical macular thickening but does not significantly affect macular thickness, regardless of glycemic status.
7	Evaluation of choroidal thickness, macular thickness, and aqueous flare after cataract surgery in patients with and without	Ikegami et al. (2020)	To assess the impact of uncomplicated small-incision phacoemulsification cataract surgery on subfoveal choroidal thickness	This study included 59 randomly selected eyes; aqueous flare, CMT, and SCT measurements were performed before and at 1 week, 1	Postoperative central macular thickness significantly increased in both groups up to 3 months, with no notable group differences. Significant	Phacoemulsification can increase inflammation in diabetic eyes. While there are significant differences in aqueous flare, there are no

	diabetes: a prospective randomized study		(SCT), central macular thickness (CMT), and aqueous flare in diabetic patients.	month, and 3 months after surgery.	differences in aqueous flare were observed before and three months after surgery, but no significant differences were found in pre- and postoperative subfoveal choroidal thickness.	differences in central macular thickness and subfoveal choroidal thickness postoperatively.
8	Outcomes of phacoemulsification on the corneal endotheliu m in diabetic versus non-diabetic patients: A prospective non-randomized controlled	Nahass et al. (2024)	To assess the effects of phacoemulsification on the corneal endotheliu m in patients with or without diabetes.	A prospective non-randomized controlled interventional study with 64 patients.	The non-diabetic group experienced a greater mean loss of endothelial cells than the diabetic group at three months postoperatively, although this difference was not	Endothelial cell density correlated with the cumulative dissipated energy (CDE) of phacoemulsification, not diabetes, and the non-diabetic group had a

	interventional study.				statistically significant.	significantly higher coefficient of variation (CV) than the diabetic group.
9	Effect of Phacoemulsification on Corneal Endothelium in Type 2 Diabetic Patients versus Normal Patients: Phacoemulsification on Corneal Endothelium	Khalifa et al. (2023)	To evaluate the impact of phacoemulsification on individuals with type 2 diabetes who have normal corneal endothelium.	This study included 80 eyes with type 2 diabetes mellitus and a group without diabetes. Specular microscopy was conducted to measure endothelial cell density.	Both groups experienced a significant reduction in endothelial cell density (ECD) one month after phacoemulsification surgery, with a greater decrease in the diabetic group.	Phacoemulsification reduces corneal endothelial cell count, and type 2 diabetes accelerates this reduction, leading to greater density loss.
10	Assesment of Macular and Retinal Nerve Fiber Layer Changes after Uncomplicated	El Khiat et al. (2021)	To assess the macular and retinal nerve fiber layer changes after phacoemul	This comparative cross-sectional study included 15 diabetic and 15 non-diabetic	The range of increased macular thickness is more in diabetic patients. RNFL thickness	The effect of phacoemulsification impacts the macula in diabetic patients, whereas

	Phacoemulsification Surgery in Diabetic Patients Using Optical Coherence Tomography	sification in the early postoperative period in diabetic and non-diabetic patients.	patients with cataracts.	showed no significant differences between diabetics and non-diabetics.	there is no significant difference in the RNFL.

DISCUSSION

Phacoemulsification with intraocular lens (IOL) implantation (Figure 1) is a quick and precise surgical procedure that involves a small incision. It is the most commonly performed surgery worldwide for cataracts treatment and is generally very safe. However, the surgeon's skill, technique, experience, and patient factors can impact the outcome. During the procedure, high-frequency ultrasound energy from the phaco tip, along with other instruments, is used within the limited space of the anterior chamber. Inevitably, this procedure causes effects after it is performed, which can lead to damage to the corneal endothelium, a layer of hexagonal cells essential for maintaining corneal clarity, and also affects the macula and RNFL (retinal nerve fiber layer). Phacoemulsification with ultrasound energy has the potential to create mechanical damage and loss of corneal endothelial cells, both of which can inhibit corneal healing after surgery. The concern that the cornea of diabetics may be more susceptible to injury during phacoemulsification stems from the fact that diabetes mellitus may affect the health of the endothelial cornea (Zhang, et al; 2021).

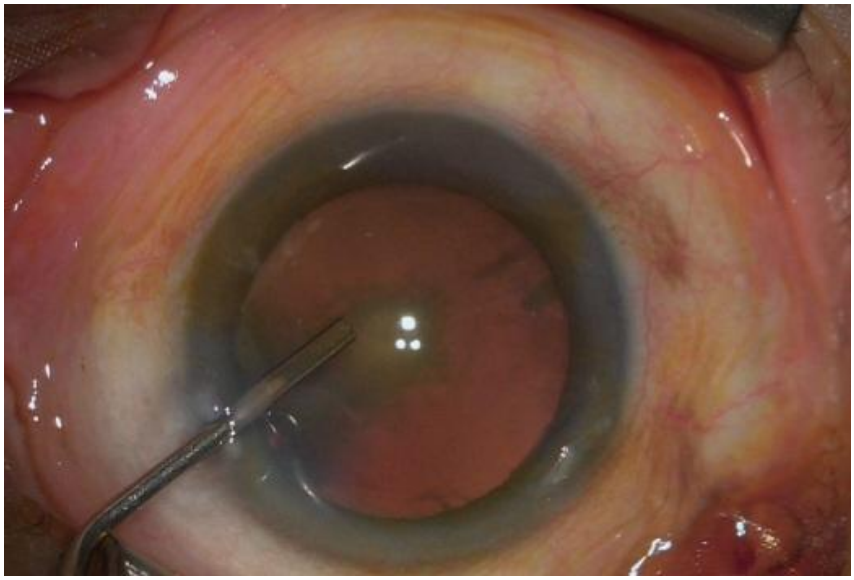

Figure 1. Early step of phacoemulsification in diabetic cataract

The results of postoperative corneal changes in healthy individuals and diabetes were inconsistent across studies. In a study conducted in 2024 by Ghany et al., it was shown that the density of corneal endothelial cells was 2629.3 ± 221 cells/mm² ($P < 0.001$), significantly lower in the diabetes group than in the non-diabetic group (Ghany et al., 2024). Yang et al. through their meta-analysis of 1,744 eyes demonstrated that diabetic patients experience greater endothelial corneal damage and slower recovery compared to non-diabetic patients (Yang et al., 2023). This finding is further supported by Khalifa et al. who reported a significant reduction in endothelial cell density one month after phacoemulsification, with diabetic patients showing a more pronounced decrease (Khalifa et al., 2023). However, contrasting results were presented by Nahass et al. who found that the non-diabetic group experienced a greater mean loss of endothelial cells at three months postoperatively, although this difference was not statistically significant (Nahass et al., 2024).

Another specific aspect to consider in diabetic patients is the change in Macular thickness and RNFL thickness after phacoemulsification. Segura et al. found similar increases in macular thickness and volume up to six months after cataract surgery in both diabetic patients without diabetic retinopathy and non-diabetic subjects. The changes in macular thickness following phacoemulsification present another important aspect for discussion (Segura et al., 2022). This finding is complemented by Hasan et al., who reported that macular thickness peaked at 6 weeks post-surgery, particularly in diabetic patients, but normalized by 12 weeks with no clinically significant difference between groups. The inflammatory response in diabetic eyes post-phacoemulsification is another crucial consideration (Hasan et al., 2023). Ikegami et al.

demonstrated increased postoperative inflammation in diabetic eyes, evidenced by significant differences in aqueous flare before and three months after surgery. However, they found no significant differences in central macular thickness and subfoveal choroidal thickness postoperatively between diabetic and non-diabetic patients (Ikegami et al., 2020). Meanwhile, changes in RNFL thickness in the study by El Khiat et al. did not show significant changes in diabetic patients but it showed results of macular thickening (El Khiat et al., 2021).

These findings collectively suggest that while diabetic patients may face increased risks and slower recovery in certain aspects, modern surgical techniques and proper post-operative care can lead to successful outcomes. Chaurasia et al. (2022) emphasized this point, noting that while diabetic patients had greater negative changes in corneal endothelium and visual acuity, understanding these differences allows for better surgical planning and post-operative care. The implications for clinical practice are significant. Additionally, studies investigating preventive measures for endothelial cell loss, macular changes and retinal nerve fiber layer changes in diabetic patients would be valuable contributions to the field.

CONCLUSION

The phacoemulsification procedure in diabetic mellitus patients suffering from cataracts requires more attention due to the potential for additional complications related to corneal conditions and inflammatory factors. The main findings of the study showed that diabetic patients experienced more significant corneal endothelial damage, a higher inflammatory response, and differences in post-operative macular thickness and retinal nerve fiber layer compared to non-diabetic patients. An integrated approach that includes endothelial monitoring and, appropriate inflammatory management strategies, as well as innovations in surgical techniques, is needed to improve clinical outcomes and reduce the risk of complications in this population.

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