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Effect of Phacoemulsification on Macular Thickness and Volume in Diabetic Patients without Retinopathy

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ABSTRACT

Introduction: This study aimed to investigate the effect of phacoemulsification on macular thickness and volume in diabetic patients without retinopathy using optical coherence tomography (OCT).
Methods: This prospective study included 37 diabetics and 55 non-diabetic patients (n=92) with cataract who were scheduled for phacoemulsification. The participants were entered into the study based on the inclusion and exclusion criteria following a complete eye examination. Macular thickness and volume were measured preoperatively as well as one month postoperatively using the OCT (Spectralis; Heidelberg Engineering, Heidelberg, Germany).
Results: The present study analyzed 76 eyes of 76 patients with immature cataract. No significant differences were observed between diabetic and non-diabetic groups in terms of thickness and volume in the macular area. However, the results showed a significant increase in both groups regarding the thickness and volume after phacoemulsification.
Conclusion: The results of the present study reveal that diabetes has no effects on the changes in macular thickness and volume after cataract surgery in diabetic eyes without retinopathy.

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Introduction

Phacoemulsification, as one of the most commonly performed surgical techniques, results in improved visual outcomes in patients with cataract (1,2). However, increased retinal thickness in response to an inflammatory insult to the eye is a common finding following phacoemulsification (3). Surgical trauma and prostaglandin release rise the capillary permeability and lead to macular edema, which may severely diminish the postoperative visual acuity (1,3,4). Moreover, vitreoretinal traction may play a pathogenic role in this condition (3).

Phacoemulsification in many cases could lead to worsening the previous retinal diseases, such as diabetic macular edema (1). Increased permeability of capillaries is the early sign of retinal changes in diabetic patients due to the abnormalities in the blood-retina barrier (5). Therefore, exacerbated diabetic macular edema or cystoid macular edema may adversely affect visual acuity in patients with diabetes mellitus after the phacoemulsification surgery (4,6,7).

Optical coherence tomography (OCT) is an objective, noncontact, and noninvasive technique for in vivo imaging of the retina and quantitative measurements with safe repeatability of the result

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over time (3,4,8).

The present study aimed to investigate the effect of uneventful phacoemulsification on macular thickness and volume in diabetic patients without retinopathy using the OCT.

Methods

In this prospective study, 92 patients with cataract, including 37 diabetic patients (type 2 diabetes mellitus without retinopathy) and 55 non-diabetic patients were scheduled for phacoemulsification surgery in one eye. The sample size was determined according to a previously conducted study (7) and considering a 95% confidence interval and 80% test power. The study population was selected from the patients with cataracts who referred to Khatam Hospital in Mashhad, Iran, within 7 months using the consecutive sampling method.

All participants underwent complete ophthalmic examinations, including a comprehensive medical and ocular history, complete fundus evaluation, and Goldmann applanation tonometry. Best-corrected visual acuity (BCVA) was measured through logMAR (logarithm of the minimum angle of resolution) acuity chart. Moreover, fasting blood glucose levels in both groups and hemoglobin A1C levels in the diabetic group were determined using the blood test. It is worth mentioning that the duration of diabetes, type of treatment, and daily medication intake of the diabetic group were also recorded in this study.

The Lens Opacities Classification System III was applied to grade the cataract severity and type. Patients with any media opacities other than cataract, previous ocular surgery, inability to capture fundus photography due to dense cataract, ocular hypertension, glaucoma history, uveitis, macular edema, age-related macular degeneration, diabetic retinopathy in the diabetic group, fasting blood sugar (FBS) greater than 120 mg/dl in the non-diabetic group, and history of retinal laser therapy were excluded from the study population.

The macular thickness of the participants was measured using the OCT (Spectralis; Heidelberg Engineering, Heidelberg, Germany) on a preoperative day. It should be noted that all measurements were performed by one experienced examiner, and images with low quality were repeated. Each macular scan was divided into nine regions recommended by the Early Treatment Diabetic Retinopathy Study (ETDRS) (9). These regions included a central fovea area, as well as inner and outer rings, which were divided into four quadrants. In addition, minimum and maximum thickness in the foveal area and mean foveal volume were also measured in this study (Figure 1).

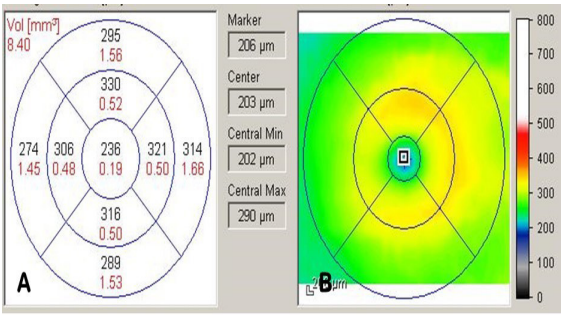

Figure 1. Sample OCT macular thickness map printout. A) Grid showing thickness values for each of the nine ETDRS areas used in the study. B) Infrared image of the macula with the overlying grid of the nine ETDRS areas.

Axial length measurement and intraocular lens power calculation were obtained using a Lenstar LS 900 (Haag-Streit AG, Koeniz, Switzerland) non-contact biometer.

All participants underwent phacoemulsification cataract surgery under topical anesthesia by an experienced cataract surgeon. The surgery included a 3-mm clear cornea incision, capsulorhexis, and implantation of a foldable hydrophobic acrylic intraocular lens in the bag. None of the diabetic patients received a simultaneous intravitreal anti-vascular endothelial growth factor injection.

The postoperative medication was similar in both groups and consisted of a topical antibiotic eye drop (Chloramphenicol 0.5% or Levofloxacin 0.5%) 6 times during the 1st week and Betamethasone 0.1% every 2 h for 1 week followed by 4 h and gradually tapered over a month.

Patients were examined using a slit lamp biomicroscopy on the 1st day and one week after surgery. Comprehensive ophthalmic examination containing visual acuity assessment, fundus examination, slit-lamp biomicroscopy, and macular thickness measurement using the OCT were performed at the 1st-month postoperative follow-up visit.

All statistical analyses were performed in SPSS software (version 11.5) (SPSSInc., Chicago, IL). The normality of the variable distribution was checked using the Shapiro-Wilk test, and the results showed non-normal distributions in most thicknesses. Therefore, the Mann-Whitney U test was utilized to detect the differences between the two groups in terms of the thickness parameters. In addition, the differences between the two groups regarding preoperative and postoperative thickness were identified using the Wilcoxon test. Spearman correlation test was also performed to assess the correlations. A p-value less than 0.05 was considered statistically significant.

Regarding the ethical considerations, written consent was obtained from all participants before enrollment in the study. Notably, the study was un-

der the tenets of the Declaration of Helsinki and was approved by the Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran.

Results

A total of 76 eyes of 76 patients with immature cataracts were analyzed in the present study. Any subjects with intraoperative and postoperative complications during follow-up, as well as those who were unwilling to complete the follow-up visit were excluded from the analysis.

There were 31 (11 males and 20 females) and 45 (17 males and 28 females) patients with the mean ages of 63.45±8.0 and 65.44±9.7 years, in the diabetic and control groups, respectively

Furthermore, out of 31 patients in the diabetic group, only two cases were treated by insulin, whereas the others received oral antidiabetic agents. The mean diabetic duration was 8.89±6.97 years in this group.

According to the results, there were no significant differences between diabetic and non-diabetic groups in terms of age and gender (P=0.348, P =0.839, respectively). In total, 15 and 25 right eyes of the diabetic and control groups underwent cataract operation, respectively. There was no significant difference between the two groups in terms of the percentage of cataract surgery in right and left eyes (P=0.538). Moreover, no statistically significant difference was found between diabetic and non-diabetic groups regarding type and severity of cataract (P=0.724, P=0.644, respectively)

Table 1 summarizes the preoperative FBS, intraocular pressure (IOP), and ocular axial length (AL) in diabetic and non-diabetic groups.

The results revealed a significant difference between diabetic and non-diabetic groups in terms of preoperative FBS. However, there were no significant differences between groups regarding preoperative IOP and AL. The HbA1c level was estimated at 7.44±2.11 in the diabetic group.

Table 1. Preoperative fasting blood sugar, intraocular pressure, ocular axial length, and best-corrected visual acuity in diabetic and non-diabetic groups.

Variables	Diabetic group	Non-diabetic group	P
FBS (mg/dL)	175.00±92.86	94.81±12.90	**0.0001**
IOP (mmHg)	13.34±2.99	13.79±3.49	0.613
AL (mm)	23.19±0.63	23.31±1.26	0.628

Significant values are marked in bold. FBS: Fasting blood sugar, IOP: Intraocular pressure, AL: Axial length.

Data are presented as mean±SD.

Table 2. Preoperative and postoperative macular thickness and volume in diabetic and non-diabetic groups. Data are presented as mean±SD.

Variables		Diabetic group	Non-diabetic group	P	*p	**p
Central circle	Preoperative	263.69±41.73	268.26±32.34	0.605	**0.0001**	**0.0001**
	Postoperative	291.42±86.08	295.97±58.29	0.800		
	Changes	35.50±68.26	28.75±54.81	0.882		
Inner Superior	Preoperative	334.31±33.65	328.98±25.01	0.446	**0.0001**	**0.0001**
	Postoperative	355.72±53.14	353.41±33.76	0.832		
	Changes	26.06±28.11	24.83±28.45	0.714		
Outer Superior	Preoperative	307.04±43.12	301.05±16.72	0.444	**0.0001**	**0.0001**
	Postoperative	323.33±49.04	311.15±30.24	0.227		
	Changes	21.57±19.82	12.78±25.46	0.316		
Inner Inferior	Preoperative	330.79±29.79	329.21±20.32	0.791	**0.0001**	**0.0001**
	Postoperative	351.50±54.11	348.97±31.27	0.812		
	Changes	26.06±34.45	18.61±21.06	0.532		
Outer Inferior	Preoperative	290.48±23.53	293.97±25.36	0.584	**0.001**	**0.003**
	Postoperative	313.91±35.17	304.46±24.45	0.229		
	Changes	19.09±19.73	8.16±26.99	0.277		
Inner Temporal	Preoperative	324.31±34.36	319.45±20.54	0.459	**0.0001**	**0.0001**
	Postoperative	345.23±52.57	344.00±38.13	0.913		
	Changes	25.31±26.24	23.83±28.92	0.558		
Outer Temporal	Preoperative	280.97±23.52	282.51±20.08	0.768	**0.0001**	**0.0001**
	Postoperative	293.69±34.90	293.53±25.82	0.983		
	Changes	13.38±17.24	10.34±27.44	0.737		
Inner Nasal	Preoperative	332.55±32.11	332.88±19.12	0.957	**0.0001**	**0.0001**
	Postoperative	356.15±62.57	354.49±30.24	0.886		
	Changes	31.25±43.28	22.03±20.46	0.539		
Outer Nasal	Preoperative	306.62±25.33	307.86±27.04	0.847	**0.0001**	**0.0001**
	Postoperative	326.19±34.84	319.28±24.26	0.349		
	Changes	22.69±30.89	10.94±13.52	0.433		
Volume	Preoperative	8.22±0.82	8.15±0.84	0.723	**0.04**	**0.0001**
	Postoperative	8.67±1.48	8.81±0.67	0.623		
	Changes	1.06±1.06	0.61±0.84	**0.032**		

Significant values are marked in bold. P=p-value of diabetic and non-diabetic groups, P*=p-value of preoperative and postoperative data in the diabetic group, P**=p-value of preoperative and postoperative data in the non-diabetic group.

Additionally, a comparison of data showed no significant differences between the two groups in terms of cataract type and degree (P=0.724, P=0.644, respectively).

Preoperative and postoperative BCVA values were 0.48±0.37 vs. 0.16±0.22 in diabetic and 0.52±0.45 vs. 0.09±0.14 in non-diabetic groups, respectively. A comparison of results illustrated significant visual improvement following operation in both diabetic and non-diabetic groups (P=0.001, P<0.001, respectively). However, the results indicated no considerable differences between diabetic and non-diabetic groups in terms of preoperative and postoperative BCVA (P=0.828, P=0.309, respectively)

In a similar vein, analysis of preoperative and postoperative macular OCT data revealed no significant differences between diabetic and non-diabetic groups regarding the thickness and volume in nine areas recommended by the ETDRS . Furthermore, a comparison of the macular thickness and volume in nine areas recommended by ETDRS indicated a significant increase in the thickness after phacoemulsification surgery in both diabetic and non-diabetic groups (Table 2).

The analysis of data indicated that total macular thickness and volume changes had no significant correlation with the duration of diabetes, FBS, and HbA1c in the diabetic group (Table 3).

Table 3. Correlation (rho value) between total macular thickness and volume .changes with the duration of diabetes, FBS, and HbA1c in the diabetic group

Variables	Duration of diabetes	FBS	HbA1c
Total thickness change	0.119	0.168	0.286
Volume change	0.201	0.217	0.152

Significant values are marked in bold.

FBS: Fasting Blood Sugar

Discussion

A cataract is a significant clinical problem, and macular edema is a serious consequence of phacoemulsification surgery (4,10,11). Although it is a temporary and self-limiting phenomenon, it may lead to a poor visual outcome in some patients after surgery (4,10,11). Several studies have reported that the incidence of cystoid macular edema is more in diabetic patients, compared to non-diabetic ones (4,10,11). The present study aimed to compare the macular thickness and visual outcome after phacoemulsification surgery in diabetic versus non-diabetic individuals.

Similar to recently conducted studies, no significant differences were noted between the diabetic and non-diabetic groups at both preoperative and postoperative visits in terms of the thickness value in any macular regions and macular volume (3,4,12,13). A significant increase in the macular thickness and volume after cataract surgery was detected in all macular regions in both diabetic and non-diabetic groups. These findings could be explained by surgical inflammation accompanying with cataract surgery, which results in a significant increase in macular thickness in both groups.

Biro et al. assessed macular thickness in diabetic patients following cataract surgery and reported no significant difference between the diabetic and non-diabetic groups on the pre and postoperative assessment in terms of the macular thickness values. However, their results showed a significant increase after one week, as well as one and two months post-surgery in both groups (12). In another study conducted by the same authors, the foveal and perifoveal thickness following cataract surgery were assessed in non-diabetic patients. They reported increased thickness of the foveal and perifoveal regions after 7, 30, and 60 days post-surgery (3).

Katsimpris et al. compared diabetic and non-diabetic patients in terms of the central foveal thickness (CFT) following cataract surgery. They revealed no significant difference between the two groups regarding preoperative CFT. They reported increased thickness postoperatively only at the 1st-month visit in the control group; however, a significant increase in CFT was observed at all follow-up periods (1st, 3rd, 6th, and 12th month) (4). The present study reported the same macular thickness finding after the 1st-month visit postoperatively, which was consistent with the results of a study conducted by Katsimpris et al.

Despite an increase in the macular volume in both diabetic and non-diabetic groups following surgery, no significant difference was observed between the two groups in terms of pre- and post-operative macular volume. Our results confirmed the findings of a study performed by Degenring et al. They investigated the effect of cataract surgery on foveal thickness and volume in diabetics and non-diabetics and reported an increase in the foveal volume 1 and 4 weeks after surgery in both groups (7).

In contrast, Jurecka et al. assessed the effect of phacoemulsification on the development of macular edema in diabetic patients and reported a significant increase in the macular volume in the diabetic group (14). According to the results of the present study, thickness and volume had no significant correlation with the duration of diabetes, FBS, and HbA1c in the diabetic group. Similar to our results, Jurecka et al. indicated no consider-

able correlation between HbA1c level and retinal thickness changes in diabetics (14). Similarly, Biro et al. noted that the preoperative macular thickness did not correlate with the duration of diabetes (12). The majority of the patients in both diabetic and non-diabetic groups obtained a significant improvement in BCVA after phacoemulsification surgery. No significant difference was observed between the two groups in terms of the amount of visual improvement. Jurecka et al. also found no significant difference between diabetic and control groups regarding the final visual outcome (14). Considering the assessment of BCVA, Haleem et al. reported a significant improvement in both groups. They also noted better visual outcomes in non-diabetics, compared to diabetics on the 6th postoperative week (11). Based on the results of the current study, the postoperative BCVA was better in non-diabetics; however, it was not statistically significant.

In addition to the relatively small and unequal sample size in each group, another limitation was a relatively short follow-up. Furthermore, specific sample composition (e.g. exclusion of those with developed CME during follow-up) reduced the generalizability of the results of the current study. However, the present study aimed to specifically assess the subtle subclinical variations in the early postoperative phase than the clinical CME. Moreover, all participants underwent phacoemulsification cataract surgery by an experienced cataract surgeon to reduce the effect of surgical experience.

Conclusion

This study led us to conclude that diabetes had no effects on an increase in the macular thickness and volume following phacoemulsification surgery in diabetic eyes without retinopathy.

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Conflict of Interest

The authors declare no conflict of interest.

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