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Changes of tear film and tear secretion after phacoemulsification in diabetic patients

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Abstract: Objective: To evaluate tear film stability and tear secretion in patients with diabetes after phacoemulsification. Methods: Twenty-five diabetic cataract patients and 20 age-matched non-diabetic cataract patients as control underwent phacoemulsification. Tear film break-up time (TFBUT), Schirmer I test (SIT), corneal fluorescein staining, and dry eye symptoms were measured pre- and postoperatively. Results: Diabetics had a decreased preoperative TFBUT and SIT. TFBUT was reduced on Day 1 and recovered on Day 180 postoperatively in both groups. SIT was increased after phacoemulsification, but returned to preoperative levels by Day 180 in non-diabetics, whereas it was lower than preoperative level in diabetics. Positive corneal fluorescein staining was elevated in both groups, and returned to preoperative levels only in controls. Dry eye symptoms were similar to fluorescein staining in both groups. Conclusion: Tear secretion was reduced in diabetic cataract patients after phacoemulsification, which worsened dry eye symptoms and predisposed those patients to ocular damage.

Key words: Phacoemulsification, Diabetes, Cataract, Tear
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INTRODUCTION

Phacoemulsification is increasingly applied in the management of cataract because of earlier refractive stabilization, reduced astigmatism, and milder postoperative inflammation. Patients with diabetes mellitus are at higher risks to develop cataract at an earlier age than non-diabetic persons (Klein *et al*., 1985). It was reported that postoperative aqueous flare is greater in diabetic patients having phacoemulsification and occurs with increased intensity with advancing retinopathy (Zaczek and Zetterstrom, 1998). However, we found in our clinical practice that many diabetic patients also complain of typical dry eye symptoms, such as burning and/or foreign body sensation after phacoemulsification, indicating tear film anomalies or a disturbance of tear function. The present study aimed at clarifing the effects of phacoemulsification on tear film stability and tear secretion postoperatively in diabetic patients.

MATERIALS AND METHODS

Patients

This study included 28 eyes of 25 patients (16 males, 9 females, mean age 64.3 years) with type II diabetes and age-related cataract. There were no other systemic disorders or diabetic retinopathy. The control group consisted of 22 eyes of 22 age-related non-diabetic cataract patients (12 males, 10 females, mean age 65.2 years). Both groups were age and sex matched. Consents were obtained from each attendant before the experiments.

Methods

All patients received preoperatively eye drops of 1.0% cyclogyl and 0.5% tropicamide for mydriasis. A standard phacoemulsification technique was used

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beginning with 0.25% bupivacaine and 2.0% lidocaine peribulbar anesthesia. A foldable posterior chamber intraocular lens was implanted in the capsular bag through a self-sealing 3.4 to 3.8 mm clear corneal incision. Postoperatively, patients received topical 0.3% ofloxacin eye drops and 0.1% fluorometholone plus diclofenac sodium eye drops. 0.3% ofloxacin eye drops were administrated 4 times per day for 7 d postoperatively, and 0.1% fluorometholone plus diclofenac sodium were dropped into eyes 4 times per day for 30 d postoperatively. A follow-up observation of 6 months was carried on. Patients were examined on Days 1, 3, 7, 30, 90 and 180 postoperatively. The ocular examinations included a tear film break-up time (TFBUT) measurement, Schirmer I test (SIT) and corneal fluorescein staining. Dry eye symptoms were also recorded. All of these examinations were conducted by an ophthalmologist who had no knowledge of the treatments.

The TFBUT test was performed using a commercial available fluorescein test paper that contacted with bottom conjunctiva. The subjects were instructed to blink 3 times, and then saw straight forward without any blink. Tear film was observed using a blue cobalt filter under wide lighting. The interval between the last blink and the appearance of the first corneal dry spot was measured. The last procedure was repeated 3 times and the mean value was recorded. A TFBUT value less than 10 s was accepted as abnormal.

The basal SIT was performed under natural light without topical anesthesia. Standardized Whatmann filter paper was placed in the lateral canthus away from the cornea and left in place for 5 min while the eye was closed. The distance moistened was measured in millimeters (mm). A reading of less than 10 mm was considered abnormal.

The cornea fluorescein staining was performed by using test paper bar of fluorescein to contact the lower fornix of eye. After 3 times of blinks, the subjects were asked to see straight forward without any blink. Under the wide blue cobalt light of the bimicroscope, the cornea was assessed. Staining in any part of the cornea was accepted as abnormal. Corneal staining of the area was graded: Grade 0, no punctate staining; Grade 1, <1/8 stained; Grade 2, 1/4 stained; Grade 3, >1/2 stained; Grade 4, entire area stained. The subjective complaints were scored by 0~12: 0, without complaints; 1, visual fatigue; 2, secretion; 3, foreign body sensation; 4, eyelids heavy; 5, dryness; 6, uncomfortable; 7, pain; 8, tears; 9, blurred vision; 10, itch; 11, photophobia; 12, eye redness. Patients who had one or more of these complaints were considered as positive.

Dry eye symptoms were characterized by burning, stinging, redness, sensation of a foreign body, photophobia, and blurred vision, and scored by the grades of 0, 0.5, 1 or 2.

Data analysis

The data were expressed as mean±*SD*. Statistical analyses were performed using SPSS 11.0 (SPSS, Inc., Chicago, IL, USA). χ^2 test was used to compare differences of corneal fluorescein staining. Student *t*-test was used to compare difference between diabetic patients and non-diabetic controls, and paired *t*-test was used to compare difference between pre- and post-operations. Any differences at $P<0.05$ were considered as statistically significant.

RESULTS

Tables 1 and 2 record the changes of TFBUT and SIT in both non-diabetic controls and diabetic patients pre- and post-phacoemulsification, respectively. Diabetic patients showed statistically significant lower preoperative TFBUT and SIT values, compared with non-diabetic controls. On Day 1 postoperatively, TFBUT values in both groups significantly decreased compared with preoperative values, and afterwards, gradually returned to the preoperative levels, as illustrated by the data recorded on Days 3, 7, 30, 90 and 180 postoperatively. The percentage of TFBUT recovery in diabetic patients (93%) on Day 180 was similar to that of the non-diabetic controls (95%). SIT values significantly increased on Day 1 postoperatively in both groups, and gradually returned to preoperative level in non-diabetic patients by Day 90 postoperatively. However, during the 180 d, the SIT value in diabetic patients (by contrast with controls) continued to reduce to 86% of the preoperative SIT level.

Both the control group and diabetic patients showed positive corneal fluorescein staining preoperatively (Table 3). The positive ratio in the diabetic patients was significantly higher than the ratio for

controls. On Day 1 postoperatively, the positive ratio increased in both groups, with values for the diabetic patients higher than those for controls. The positive ratio in the controls then gradually returned to the preoperative levels on Days 90 and 180. However, the diabetics still exhibited a significantly higher positive ratio of fluorescein staining compared with either preoperative values or values for controls (Table 3).

Table 4 shows the grades of dry eye symptoms in both groups pre- and postoperatively. Both non-diabetic and diabetic patients had more severe dry eye symptoms on Days 1 to 7 postoperatively. Thereafter, the grades of dry eye symptoms returned to preoperative levels between Days 30 and 180 in the non-diabetic group, and however, remained elevated in diabetics even on Day 180 postoperatively.

Table 1 Comparison of pre- and postoperative tear film break-up time (TEBUT) in non-diabetic and diabetic patients

	Non-diabetes		Diabetes	
	n_{eyes}	*TEBUT* (s)	n_{eyes}	*TEBUT* (s)
Preoperation	22	10.2±0.8	28	8.0±1.6[a]
Postoperation				
Day 1	22	5.7±0.6[b]	28	5.6±1.1[b]
Day 3	20	6.2±0.6	26	6.0±1.2
Day 7	18	7.1±0.6	22	6.2±0.9
Day 30	16	9.1±0.6	22	6.6±1.1
Day 90	20	9.3±0.9	21	7.4±1.1
Day 180	20	9.7±0.9	21	7.5±1.2

Data are expressed as mean±*SD*. [a]$P<0.05$ compared with preoperative non-diabetic TFBUT; [b]$P<0.05$ compared with corresponding preoperative TFBUT

Table 2 Comparison of pre- and postoperative Schirmer I test (SIT) in non-diabetic and diabetic patients

	Non-diabetes		Diabetes	
	n_{eyes}	*SIT* (mm)	n_{eyes}	*SIT* (mm)
Preoperation	22	12.7±1.0	28	7.8±1.8[a]
Postoperation				
Day 1	22	20.5±2.5[b]	28	16.5±1.9[b]
Day 3	19	18.1±1.2	26	14.4±1.9
Day 7	18	14.5±0.8	22	12.0±1.8
Day 30	16	13.3±0.8	20	10.0±1.7
Day 90	16	12.5±0.8	20	7.1±1.7
Day 180	16	12.4±0.9	20	6.7±1.2[c]

Data are expressed as mean±*SD*. [a]$P<0.05$ compared with preoperative non-diabetic SIT; [b]$P<0.05$ compared with corresponding preoperative SIT; [c]$P<0.05$ compared with the preoperative value for diabetics

Table 3 Comparison of pre- and postoperative corneal fluorescein staining (CFS) in non-diabetic and diabetic patients

	Non-diabetes			Diabetes		
	n_{eyes}	CFS (+)	CFS (%)	n_{eyes}	CFS (+)	CFS (%)
Pre-op	22	3	13.6	28	6	21.4[a]
Post-op						
Day 1	22	5	22.7[b]	28	9	32.1[b]
Day 3	20	2	10.0	19	7	36.8
Day 7	18	2	11.1	20	7	35.0
Day 30	16	2	12.5	18	6	33.3
Day 90	16	2	12.5	17	6	35.3
Day 180	16	2	12.5	16	5	31.2[c]

Pre-op: Preoperation; Post-op: Postoperation. [a]$P<0.05$ compared with preoperative non-diabetic CFS; [b]$P<0.05$ compared with corresponding preoperative CFS; [c]$P<0.05$ compared with the preoperative value for diabetics

Table 4 Comparison of pre- and postoperative dry eye symptoms (DES) in non-diabetic and diabetic patients

	Non-diabetes					Diabetes				
	n_{eyes}	Grade of DES				n_{eyes}	Grade of DES			
		0	0.5	1	2		0	0.5	1	2
Pre-op	22	14	6	2	0	28	10	16	2	0[a]
Post-op										
Day 1	22	3	6	12	1[b]	28	3	8	14	3[b]
Day 3	20	5	6	8	1	26	5	7	12	2
Day 7	18	8	4	6	0	22	6	12	3	1
Day 30	16	10	4	2	0	22	7	12	3	0
Day 90	20	12	6	2	0	21	8	12	1	0
Day 180	20	14	6	0	0	21	9	11	1	0[c]

Pre-op: Preoperation; Post-op: Postoperation. Grade 0: No DES; Grade 0.5: Seldom or trace of DES; Grade 1: Sometimes or mild DES; Grade 2: Frequent or moderate DES. [a]$P<0.05$ compared with preoperative non-diabetic DES; [b]$P<0.05$ compared with corresponding preoperative DES; [c]$P<0.05$ compared with corresponding non-diabetic DES

DISCUSSION AND CONCLUSION

In the present study, we found that phacoemulsification affected tear production postoperatively in diabetic cataract patients whose SIT had decreased, causing a risk for the cornea to be damaged and dry eye symptoms. Patients with diabetes mellitus have a higher likelihood of developing cataracts (Klein *et al*., 1985). It has been estimated that up to 20% of all cataract surgeries are performed on diabetic patients (Hamilton *et al*., 1996).

Cataract extraction in diabetic patients is important as it improves visual acuity (Antcliff *et al*.,

1996) and thus quality of life. Phacoemulsification is currently used as a method for cataract therapy. However, the effects of this surgery on tear function including tear production and tear film stability are seldom studied. Ram *et al*.(2002) reported that phacoemulsification did not change TFBUT and SIT scores in patients with dry eye. However, Liu *et al*. (2002) found that phacoemulsification reduced the TFBUT in non-diabetic patients.

We also found that TFBUT returned to preoperative levels both in non-diabetic and diabetic patients during the 180 d after the surgery. However, the SIT was reduced in diabetic patients compared with controls over the same observation period. This observation indicates that phacoemulsification has a greater effect on tear production in diabetic patients than in controls. Although mechanisms underlying this finding are unclear, we speculate that both diabetes mellitus and phacoemulsification may have effects on tear production and that a combination of the disease and the procedure may contribute to the increased dry eye symptoms.

Dogru *et al*.(2001) reported previously that TFBUT and SIT scores significantly decreased in non-insulin-dependent diabetes mellitus (Dogru *et al*., 2001), and suggested that diabetic neuropathy affected the innervation of the lacrimal gland, and that fluctuation in the glycemic control may affect the lacrimal gland secretory function. Furthermore, they also found a decrease in goblet cell numbers in diabetic patients, and hypothesized that this reduction in goblet cell numbers may account for the shortening of TFBUT and instability of the tear film as a result of decreased mucin production. Similarly, Ozdemir *et al*. (2003) found that TFBUT and SIT scores were lower, and the ratio of fluorescein staining was higher in patients with diabetes mellitus compared with control subjects, and suggested that peripheral neuropathy—a common diabetic complication—may affect the nerves supplying the ocular surface and tear glands. Goebbels (2000) reported that the SIT score significantly decreased whilst the TFBUT value was unchanged in insulin-dependent diabetes, and suggested that the decreased SIT score indicated a decreased amount of reflex tearing due to a diminished corneal and conjunctival sensitivity in diabetics. Our present preoperative data in diabetic patients are comparable to those of Goebbels (2000) who demonstrated further that diabetes mellitus indeed impairs tear production, causing the cornea to be at risk of damages. Moreover, diabetes mellitus is associated with increased oxidative stress and free radical production (Dandona *et al*., 1996; Peponis *et al*., 2002; Yan *et al*., 1994). Free radical production can damage epithelial tissues, such as conjunctiva and lacrimal glands (Blades *et al*., 2001). On the other hand, the ultrasound of phacoemulsification can result in free radical formation (Takahashi, 2005). We, therefore, speculate that when undergoing the phacoemulsification procedure, the diabetic cataract patient will suffer more damage to the conjunctiva, lacrimal glands, goblet cells and peripheral nerve innervation to these structures, not only from diabetes mellitus per se, but also from the surgical procedure. These effects would adversely affect tear production and function as well as corneal structure in diabetic patients. Tear formation is an elemental factor for normal ocular physiological function; both tear production and tear film stability are important for maintaining eyes. In the present study, although the TFBUT values in diabetic patients returned to the preoperative levels during the 180 d after the surgery, the SIT value of post-phacoemulsification was lower than that of pre-phacoemulsification. This result means that tear production was even weakened after the surgery, when basal tear secretion in diabetic patients already diminished relatively to that of controls. Due to the lack of tearing, the cornea of diabetic patients is more prone to damage, and patients suffer more dry eye. Therefore, we suggest the use of artificial tear preparations postoperatively for diabetics in order to attenuate their corneal damage and dry eye symptoms from phacoemulsification procedure.

Phacoemulsification reduced tear secretion in diabetic cataract patients postoperatively. It is necessary to use artificial tear preparations for attenuating corneal damage and dry eye symptoms.

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