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CLINICAL TRIAL REPORT

Effect of Eyelid Hygiene on Functional Visual Acuity After Cataract Surgery: A Randomized Controlled Study

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Purpose: To evaluate the effect of eyelid hygiene after cataract surgery on eyelid and ocular surface findings, subjective symptoms and visual function, including functional visual acuity (FVA) and higher order aberration, in a randomized controlled study.

Methods: Fifty patients who underwent cataract surgery at a single institution were involved. Twenty-five patients were instructed to wipe their eyelids twice a day from one to four weeks postoperatively, whereas the other 25 patients did not perform any eyelid hygiene. Optical measurement, FVA, meibomian glands, the grade of meibum, lid margin findings, fluorescein corneal staining findings, dry eye-related subjective symptoms and surgical satisfaction were assessed both preoperatively and one month postoperatively.

Results: In the eyelid hygiene group, the visual maintenance ratio of FVA improved significantly ($p = 0.048$) and the higher order aberration of the 4th + 6th order deteriorated less ($p = 0.027$) compared with the control group. Multiple regression analyses showed that the change in visual maintenance ratio was associated with surgical satisfaction ($p = 0.003$), change in corneal staining score ($p = 0.007$), history of eye diseases ($p = 0.029$) and eyelid hygiene ($p = 0.048$).

Conclusions: Eyelid hygiene after cataract surgery may be effective for visual function measured with an FVA test.

Keywords: cataract surgery, dry eye, eyelid hygiene, functional visual acuity, higher order aberration, meibomian gland dysfunction, visual maintenance ratio

Introduction

Meibomian gland dysfunction (MGD) is a chronic condition of ocular discomfort caused by abnormal function of the meibomian glands. The quality and quantity of meibum is reduced, resulting in shortening of the tear film break-up time (BUT), which can lead to dry eyes and is a major cause of posterior blepharitis. MGD and dry eye symptoms are known to worsen after cataract surgery.[1–3] According to previous reports, BUT and structural changes in the meibomian glands vary,[1–4] possibly due to differences in examination timings between reports or the severity of MGD at baseline.

To emphasize the clinical significance of managing dry eye symptoms around ocular surgery, the American Society of Cataract and Refractive Surgery developed an ocular surface disease (OSD) algorithm for ocular surgery patients.[5] According to the algorithm, patients are screened for OSD, and if found to have OSD, including MGD, they are recommended to get appropriate and effective treatment before ocular surgery.

Postoperative dry eye symptoms are known to worsen, especially in patients with pre-existing MGD.[6] Therefore, several reports suggest management of MGD before ocular surgery. Eom et al[7] reported that eyelid hygiene before and after cataract surgery improved postoperative subjective symptoms related to dry eye and prevented the exacerbation of meibum gland expressibility and secretion scores. Also, Peral et al[8] reported that eyelid hygiene before cataract surgery reduced the amount of microbiota in the eyelids. Whilst there are numerous reports about changes in ocular surface

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findings and subjective symptoms after eyelid hygiene, none of them have examined the effect on functional visual acuity (FVA), which reflects visual function in daily life.

The aim of this study was to evaluate the effect of eyelid hygiene on FVA and ocular surface findings after cataract surgery.

Methods

Study Design and Ethical Issues

This study was a prospective, single-center, parallel-group, randomized controlled trial. The study protocol was approved by the institutional review board of the University of Keio. Written informed consent was obtained from each patient participating in the study. In accordance with the provisions of the Declaration of Helsinki (1995), approval was obtained from the Ethics Committee of the Keio University School of Medicine (approved on 8 July 2020, reference 20190131).

The trial was registered as a randomized controlled trial titled "The eyelid hygiene after cataract surgery" with the University Hospital Medical Information Network (UMIN) registration number UMIN 000038320.

Patient Enrollment

A total of 50 patients who visited Otake Ophthalmology between January 2019 and March 2020 that were found to have cataracts and scheduled to undergo cataract surgery were enrolled. The participants were eligible if they were older than 60 years of age. Those who had complications during cataract surgery were excluded.

Cataract Surgery and Eyelid Hygiene Procedure

Cataract surgery was performed with phacoemulsification and aspiration by one experienced surgeon. A 2.4 mm corneal or corneoscleral incision was selected for the wound construction after topical anesthesia (4.0% lidocaine hydrochloride) during cataract surgery. Either a superior or temporal incision was selected for the incision position. All patients were prescribed topical 0.3% gatifloxacin hydrate three days prior to the surgery, and topical 1.5% levofloxacin hydrate, 0.1% bromfenac sodium hydrate, and 0.1% dexamethasone sodium phosphate after the surgery. Bromfenac contained 0.005% benzalkonium chloride as a preservative. All patients were instructed to not get water into the operated eye nor wash their face for one week after surgery. Either a multifocal or monofocal intraocular lens was inserted, and the power of the intraocular lens was also recorded.

Participants were randomly assigned to either an eyelid hygiene group or control group before the cataract surgery using a computer-generated random number table with an allocation ratio of 1:1. We provided patients with a leaflet to guide them on how to clean their eyelid. Each participant in the eyelid hygiene group received absorbent cotton swabs (0.02% chlorhexidine gluconate) and were told to use them to wipe the edge of their upper and lower eyelashes twice a day (morning and night) from one week after surgery up until four to six weeks after the surgery.

Ophthalmic Examinations

All examinations were performed by masked examiners. At the initial visit before the surgery, background information, such as age, sex, underlying disease and history of ophthalmic disease, was collected. At both the pre-operation visit and post-operation visit a month after the surgery, all participants were assessed for visual acuity, FVA, meibomian gland findings, lid margin signs, corneal staining with fluorescein, central corneal thickness, axial length of their eyes and higher order aberrations (HOAs). The size and location of the incision was also recorded. In addition to the preoperative and postoperative measurements, changes before and after the surgery were calculated.

Five-meter best corrected visual acuity was measured and then converted to logMAR (logarithm of the minimum angle of resolution). We also performed FVA testing [AS-28, Kowa Company, Ltd., Aichi, Japan], and recorded FVA (the mean timewise change in visual acuity), maximal and minimal visual acuity during the examination, the visual maintenance ratio (the ratio of the starting visual acuity logMAR to the FVA logMAR) and average response time.

Meibomian glands were evaluated for morphological changes on the upper and lower lids with the use of a noncontact meibography system. Changes included flexion, dilatation, contraction and dropout and were expressed as a binary output: 0, absent; 1, present. The quality of expressed meibum and the degree of ease of expressing meibum

was graded as: grade 0, clear fluid easily expressed; grade 1, cloudy meibum expressed with mild pressure; grade 2, cloudy meibum expressed with intermediate pressure; and grade 3, meibum could not be expressed. The dropout of meibomian glands was scored on a scale of 0 to 3 according to the area of the dropout: 0, no dropout; 1, dropout area less than one-third of area; 2, between one-third and two-thirds of area; 3, more than two-thirds of area.

Lid margin findings were also obtained using a slit-lamp microscope. Telangiectasia, irregularity, plugging and foaming was assessed on a scale from 0 to 3: 0, no findings; 1, mild findings; 2, moderate findings; and 3, severe findings. The location of the mucocutaneous junction was assessed on a scale from 0 to 3: 0, Marx line runs on the ocular side from the meibomian gland orifice; 1, Marx line partially overhanging the meibomian gland orifice; 2, Marx line runs along the meibomian orifice line; and 3, Marx line runs along the eyelid margin side of the meibomian orifice line.

After fluorescein staining of each eye, a standardized grading system of 0 to 3 was used for the auricular conjunctiva, cornea and nasal conjunctiva, and then scores were combined for a 9-point scale defined as the superficial punctate keratopathy (SPK) score. In addition to evaluation of the tear meniscus, BUT was also measured three times in each eye, and the average of the three measurements was used as the BUT.

Corneal wavefront aberrations were measured using Zernike polynomials from the topography map (OPD-Scan II, Nidek Co., Ltd., Gamagori, Japan) over a 4 mm diameter zone centered on the corneal vertex. The Zernike coefficients for corneal surface aberration parameters from the 3rd to the 6th order were studied, and the root mean square value for the 3rd, 4th, 3rd plus 5th, 4th plus 6th, and the total HOAs from the 3rd to 4th, and from 3rd to 6th were calculated.

Questionnaires

The Standard Patient Evaluation of Eye Dryness questionnaire (SPEED)[9] was used to evaluate discomfort due to eye dryness, and the visual analogue scale, expressed as a percentage, was used to evaluate satisfaction with the surgery.

Statistical Analysis

All data were analyzed using IBM SPSS version 27 (New York, USA) and based on a per protocol principle. Descriptive analyses were conducted and shown as the mean and standard deviation. Differences in outcomes were compared with a Mann–Whitney *U*-test. Changes in lid margin findings were assigned into three categories (exacerbated, unchanged, improved) and compared with the ratio of each category between the lid hygiene group and control group using a chi-square test. We performed a multiple-regression analysis for visual maintenance ratio since significant change was identified in the eyelid scrub group. A multivariate estimate was performed using a stepwise method for the variables where the p-value of univariate estimate was less than 0.20. A p-value <0.05 was considered statistically significant.

Results

Fifty patients (23 men, 27 women) were included in this study according to the selection criteria. The mean age was 74.1 ± 6.4 years. Patients were randomized into 25 (50%) in the lid hygiene group and 25 (50%) in the control group (Table 1). The surgical incision site was superior in 82.6% of the control group and 87.5% of the lid hygiene group (p = 0.95).

Table 1 Baseline Characteristics of Participants

Clinical Characteristics	Control Group[a]	Eyelid Hygiene Group[a]
Sex (male/female)	10/15	13/12
Age, mean (SD), y	74.4 (6.4)	73.8 (6.5)
Patients with a history of eye disease[b]	3 (12%)	5 (20%)
Patients with diabetes mellitus	4 (16%)	4 (16%)
Patients with other systemic disorders[c]	12 (48%)	16 (64%)

Notes: [a]n (%) unless indicated otherwise. [b]Dry eye, trichiasis, epiretinal membrane, glaucoma and branch retinal vein occlusion. [c]Hypertension, Meniere disease, anemia, osteoporosis, insomnia, gastric ulcer, breast cancer, stroke, Graves' disease, epilepsy, myasthenia gravis, gout, atrial fibrillation and hepatitis C.
Abbreviation: SD, standard deviation.

Comparison Between the Lid Hygiene Group and Control Group

Preoperative ocular examination results are shown in Table 2. Meibo score (p = 0.047) and meibomian gland dropout (p = 0.004) were significantly better in the lid hygiene group. Postoperative ocular examination results are shown in Table 3. BUT was significantly longer in the control group (p = 0.034), and the parameters of FVA tended to be better in the lid hygiene group.

Changes in measured values are shown in Table 4. Changes in lid margin findings were divided into three categories (exacerbated, unchanged, improved), and a chi-square test was performed (Table 5). The lid hygiene group exhibited significant improvements in the visual maintenance ratio of FVA (p = 0.048) and significantly less increase in HOA of the 4th + 6th order (p = 0.027). There were no significant differences between the lid hygiene group and controls in BUT, SPK score or SPEED score. There were also no significant differences in the changes in lid margin findings between the lid hygiene group and controls.

Table 2 Preoperative Clinical Measurements of Eyelid Hygiene Group and Control Group

Variables	Control[a]	Lid Hygiene Group[a]	p-value
UDVA (logMAR)	0.52 (0.39)	0.68 (0.45)	0.21
CDVA (logMAR)	0.19 (0.22)	0.20 (0.23)	0.94
Mean VA (logMAR)	0.45 (0.24)	0.46 (0.28)	1.0
Visual maintenance ratio	0.91 (0.069)	0.88 (0.083)	0.26
Maximal VA (logMAR)	0.28 (0.25)	0.29 (0.28)	0.99
Minimal VA (logMAR)	0.65 (0.27)	0.67 (0.30)	0.76
Average response time (s)	1.4 (0.14)	1.4 (0.19)	0.49
Tear meniscus height (1-low, 2-normal, 3-high)	2.2 (0.57)	1.9 (0.29)	0.056
BUT (s)	5.5 (2.8)	3.8 (2.5)	0.075
SPK score	0.33 (0.82)	0.48 (0.85)	0.34
Lid margin findings (out of 3)			
Telangiectasia	0.63 (0.77)	0.39 (0.58)	0.22
Irregularity	0.21 (0.42)	0.30 (0.47)	0.75
Plugging	0.96 (0.91)	0.70 (0.70)	0.21
Foaming	0.0 (0.0)	0.0 (0.0)	1.0
MCJ abnormalities	0.71 (0.81)	0.70 (0.77)	0.98
Meibomian gland evaluation			
Meibo score (out of 3)	1.2 (0.83)	0.74 (0.86)	**0.047**
Flexion (0, absent; 1, present)	0.33 (0.48)	0.26 (0.45)	0.83
Dilatation (0, absent; 1, present)	0.080 (0.28)	0.040 (0.21)	0.32
Contraction (0, absent; 1, present)	0.46 (0.51)	0.35 (0.49)	0.45
Dropout (0, absent; 1, present)	0.50 (0.51)	0.13 (0.34)	**0.004**
Meibum grade (out of 3)	0.83 (1.0)	0.57 (0.84)	0.25
SPEED score	2.8 (2.7)	4.4 (4.2)	0.47
Preoperative CCT (μm)	543.8 (28.05)	546.8 (27.49)	0.68
AL (mm)	23.7 (1.09)	24.5 (1.65)	0.056
Higher order aberrations			
3rd order (μm)	0.38 (0.36)	0.36 (0.23)	0.80
4th order (μm)	0.15 (0.13)	0.10 (0.059)	0.27
3rd + 4th order (μm)	0.42 (0.37)	0.39 (0.22)	0.62
3rd + 5th order (μm)	0.40 (0.38)	0.39 (0.23)	0.67
4th + 6th order (μm)	0.17 (0.16)	0.12 (0.065)	0.15
Total HOAs (μm)	0.45 (0.40)	0.41 (0.22)	0.60

Notes: [a]Data are presented as mean (standard deviation) or number of patients (% of patients). Bold font indicates p<0.05.

Abbreviations: AL, axial length of the eye; BUT, tear film break-up time; CCT, central corneal thickness; CDVA, corrected distant visual acuity; HOA, higher order aberration; MCJ, mucocutaneous junction; SPEED, Standard Patient Evaluation of Eye Dryness; SPK, superficial punctate keratopathy; UDVA, uncorrected distant visual acuity; VA, visual acuity.

Table 3 Postoperative Clinical Measurements of Eyelid Hygiene Group and Control Group

Variables	Control[a]	Lid Hygiene Group[a]	p-value
UDVA (logMAR)	0.15 (0.23)	0.24 (0.30)	0.15
CDVA (logMAR)	−0.016 (0.10)	−0.043 (0.080)	0.27
Mean VA (logMAR)	0.24 (0.22)	0.16 (0.22)	0.12
Visual maintenance ratio	0.91 (0.068)	0.93 (0.064)	0.13
Maximal VA (logMAR)	0.084 (0.18)	0.035 (0.20)	0.18
Minimal VA (logMAR)	0.45 (0.29)	0.32 (0.24)	0.080
Average response time (s)	1.4 (0.13)	1.4 (0.15)	0.62
Tear meniscus height (1-low, 2-normal, 3-high)	1.8 (0.57)	1.8 (0.64)	0.93
BUT (s)	5.4 (2.8)	3.7 (2.7)	**0.034**
SPK score	0.17 (0.48)	0.21 (0.42)	0.45
Lid margin findings (out of 3)			
Telangiectasia	0.42 (0.58)	0.63 (0.58)	0.14
Irregularity	0.33 (0.64)	0.21 (0.51)	0.51
Plugging	0.79 (0.72)	0.67 (0.76)	0.60
Foaming	0.21 (0.59)	0.13 (0.34)	0.96
MCJ abnormalities	0.83 (0.76)	0.83 (0.82)	0.93
Meibomian gland evaluation			
Meibo score (out of 3)	1.0 (0.96)	0.79 (0.88)	0.33
Flexion (0, absent; 1, present)	0.25 (0.44)	0.38 (0.50)	0.48
Dilatation (0, absent; 1, present)	0.040 (0.20)	0.0 (0.0)	0.33
Contraction (0, absent; 1, present)	0.46 (0.51)	0.25 (0.44)	0.17
Dropout (0, absent; 1, present)	0.38 (0.50)	0.21 (0.42)	0.25
Meibum grade (out of 3)	0.83 (0.82)	0.88 (1.1)	0.68
SPEED score	2.2 (2.5)	2.8 (2.7)	0.38
Postoperative CCT (μm)	552.8 (27.02)	555.9 (31.93)	0.85
Rate of satisfaction (VAS) (%)	84.1 (19.1)	90.1 (12.1)	0.66
Higher order aberrations			
3rd order (μm)	0.99 (2.9)	0.40 (0.46)	0.98
4th order (μm)	0.93 (3.6)	0.30 (0.39)	0.47
3rd + 4th order (μm)	1.4 (4.6)	0.51 (0.59)	0.69
3rd + 5th order (μm)	1.3 (4.3)	0.50 (0.63)	0.98
4th + 6th order (μm)	1.1 (4.1)	0.36 (0.49)	0.35
Total HOAs (μm)	1.7 (5.9)	0.63 (0.79)	0.86

Notes: [a]Data are presented as mean (standard deviation) or number of patients (% of patients). Bold font indicates $p<0.05$.

Abbreviations: AL, axial length of the eye; BUT, tear film break-up time; CCT, central corneal thickness; CDVA, corrected distant visual acuity; HOA, higher order aberration; MCJ, mucocutaneous junction; SPEED, Standard Patient Evaluation of Eye Dryness; SPK, superficial punctate keratopathy; UDVA, uncorrected distant visual acuity; VA, visual acuity; VAS, visual analogue scale.

Factors Associated with FVA

Surgical satisfaction ($\beta = 0.0020$; $p = 0.003$), changes in SPK score ($\beta = -0.040$; $p = 0.007$), history of eye disease ($\beta = -0.064$; $p = 0.029$), and eyelid hygiene ($\beta = 0.041$; $p = 0.048$) were significantly related to changes in the visual maintenance ratio (Table 6).

Discussion

The present study demonstrated the visual maintenance ratio of FVA was significantly improved in the lid hygiene group compared with controls. Regression analysis confirmed this finding where the change of visual maintenance ratio correlated with lid hygiene. The FVA test is used to assess the effect of time on visual acuity and is known to deteriorate in diseases that cause instability of the ocular surface environment, such as dry eye.[10] Kaido et al[11] found dry eye patients had a significantly lower visual maintenance ratio compared to non-dry eye patients. Shimazaki et al[12] reported both the

Table 4 Changes in Clinical Measurements in Eyelid Hygiene and Control Groups

Variables	Control[a]	Lid Hygiene Group[a]	p-value
UDVA (logMAR)	−0.35 (0.44)	−0.37 (0.46)	0.67
CDVA (logMAR)	−0.20 (0.26)	−0.27 (0.25)	0.71
Mean VA (logMAR)	−0.20 (0.31)	−0.33 (0.31)	0.13
Visual maintenance ratio	0.0042 (0.085)	0.039 (0.091)	**0.048**
Maximal VA (logMAR)	−0.20 (0.33)	−0.29 (0.31)	0.28
Minimal VA (logMAR)	−0.18 (0.27)	−0.37 (0.37)	0.084
Average response time (s)	0.035 (0.16)	0.062 (0.15)	0.63
BUT (s)	0.46 (2.9)	−0.16 (2.6)	0.26
SPK score	−0.050 (0.62)	−0.32 (0.82)	0.53
Meibum grade (out of 3)	0.0 (1.2)	0.21 (0.86)	0.81
Higher order aberrations			
3rd order (μm)	0.61 (2.8)	0.040 (0.58)	0.63
4th order (μm)	0.78 (3.5)	0.19 (0.37)	0.062
3rd + 4th order (μm)	0.98 (4.4)	0.12 (0.69)	0.92
3rd + 5th order (μm)	0.93 (4.1)	0.12 (0.74)	0.63
4th + 6th order (μm)	0.88 (3.9)	0.24 (0.48)	**0.027**
Total HOAs (μm)	1.3 (5.7)	0.22 (0.88)	0.92

Notes: [a]Data are presented as mean (standard deviation) or number of patients (% of patients). Bold font indicates $p<0.05$.

Abbreviations: AL, axial length of the eye; BUT, tear film break-up time; CCT, central corneal thickness; CDVA, corrected distant visual acuity; HOA, higher order aberration; SPK, superficial punctate keratopathy; UDVA, uncorrected distant visual acuity; VA, visual acuity.

Table 5 Comparison of Changes in Lid Margin Findings and Meibo Score Between Lid Hygiene and Control Groups

Lid Margin Findings		Exacerbated[a]	Stable[a]	Improved[a]	χ^2	p-value
Telangiectasia	Control	0	23	2	2.1	0.15
	Lid hygiene	0	25	0		
Irregularity	Control	1	24	0	1.0	0.31
	Lid hygiene	0	25	0		
Plugging	Control	0	22	3	2.1	0.35
	Lid hygiene	2	20	3		
Foaming	Control	2	23	0	2.1	0.15
	Lid hygiene	0	25	0		
MCJ abnormality	Control	1	24	0	0.36	0.55
	Lid hygiene	2	23	0		
Meibo score	Control	0	23	2	2.1	0.15
	Lid hygiene	0	25	0		

Note: [a]Data are presented as the number of patients.

Abbreviation: MCJ, mucocutaneous junction.

short BUT dry eye group and aqueous-deficiency dry eye group showed a significantly lower visual maintenance ratio compared with normal eyes.

To the best of our knowledge, our current study is the first to describe the effect of lid hygiene on FVA, with no effect observed on BUT. This apparent discrepancy may be due to the visual maintenance ratio improving in the lid hygiene group before subsequent environmental changes on the ocular surface are detected with BUT, SPK score and lid margin

Table 6 Factors Associated with Changes in Visual Maintenance Ratio

Variables	Univariate Estimate	Multivariate Estimate	
	p-value	β	p-value
Lid hygiene	0.056[a]	0.041	**0.048**
Sex (male/female)	0.49		
Age (y)	0.76		
History of eye diseases (0: negative; 1: positive)	0.18[a]	−0.064	**0.029**
IOL power (D)	0.59		
Changes in CDVA (logMAR)	0.35		
Changes in SPEED score	0.52		
Changes in BUT	0.58		
Changes in SPK score	0.17[a]	−0.040	**0.007**
Rate of satisfaction (VAS) (%)	0.008[a]	0.0020	**0.003**
Corneal incision	0.98		
Scleral incision	0.55		
Corneoscleral incision	0.76		
Temporal incision	0.78		
AL (mm)	0.55		
Changes in ECD	0.63		
Changes in CCT (μm)	0.15[a]		0.17
Changes in 3rd order (μm)	0.075[a]		0.65
Changes in 4th order (μm)	0.47		
Changes in 3rd + 4th order (μm)	0.13[a]		0.75
Changes in 3rd + 5th order (μm)	0.067[a]		0.70
Changes in 4th + 6th order (μm)	0.53		
Changes in total HOAs (μm)	0.12[a]		0.76

Notes: [a]Multivariate estimate was performed if variables had p-values less than 0.20 in univariate estimate. Bold font indicates $p<0.05$.

Abbreviations: AL, axial length of the eye; BUT, tear film break-up time; CCT, central corneal thickness; CDVA, corrected distant visual acuity; ECD, endothelial cell density; HOA, higher order aberration; IOL, intraocular lens; SPEED, Standard Patient Evaluation of Eye Dryness; SPK, superficial punctate keratopathy; VAS, visual analogue scale.

status. Indeed, further improvements may be observed with a longer intervention and observation period since a previous study found preoperative intervention resulted in a distinct improvement in lid and corneal findings.[7] There is a report suggesting that performing lid hygiene and warm compresses preoperatively for patients with MGD can alter astigmatism and axis, leading to a reduction in residual astigmatism postoperatively. Therefore, it is recommended to conduct preoperative biometry measurements before surgery in patients who have undergone MGD treatment.[13] Consequently, lid hygiene is necessary not only postoperatively but also preoperatively. We suggest the change in the visual maintenance ratio is associated with lid hygiene. This is because the visual maintenance ratio is a sensitive indicator of the stability of the ocular surface environment. This is consistent with a previous study, which showed that in dry eyes with shortened BUT, visual acuity improved with each blink of the eye in an FVA test, but decreased as soon as the eye was kept open, resulting in a saw-shaped graph with a low visual maintenance ratio.[10]

In the current study, the sum of 4th + 6th order increased significantly less in the lid hygiene group, indicating a certain effect of postoperative lid hygiene. An association between dry eye and HOA has been previously reported. According to Montés-Micó et al.[14] HOA in the 4th order, the sum of the 3rd, 4th and 5th orders, and the sum of the 3rd and 5th orders are significantly worse in dry eyes. Our study findings support prior studies that show a beneficial effect of dry eye treatment on HOA[15] and FVA with the use of diquafosol tetrasodium ophthalmic solution[16] and the insertion of a lacrimal punctal plug.[17,18] It has been shown that superior incisions and temporal incisions are different in the induction effect of postoperative HOAs although superior incisions have been selected by most study groups without statistical significance. Jeong et al[19] reported that superior incision in eyes with with-The-rule astigmatism resulted in higher

surgically induced astigmatism than in eyes with temporal incision with against-The rule astigmatism. Moreover, HOAs significantly decreased in eyes with with-The-rule astigmatism and superior incision. Thus, a superior incision could more effectively reduce corneal astigmatism in eyes with with-The-rule astigmatism.

We found lid hygiene had favorable effects on several parameters of FVA and HOA. Even if lid wiping did not sufficiently clean the lid margin, this procedure may have promoted enhanced blinking that helped maintain a healthy ocular surface. Previous investigations suggest frequent and vigorous blinking is effective in dry eye.[20,21] The present procedure continued for more than three weeks using a cotton swab, thus potentially producing comparable effects to blinking exercises. Additionally, better optical quality was achieved by a decrease in SPK score in the lid hygiene group since a change in visual maintenance ratio correlated with SPK score.

Elimination of microorganisms may be another possible effect of the current lid hygiene procedure, although culture examination was not performed in this study. Lid hygiene reduces not only microbiota on the eyelid but also demodex mites on the eyelid.[8,22,23] Demodex mites are commonly found in the eyelashes of elderly and dry eye patients. Previous reports revealed they cause negative changes on the eyelid and are responsible for anterior and posterior blepharitis.[23] It could be speculated that lid wiping with a cotton swab might have relieved the effect by demodex mites.

The lack of significant differences in the changes in eyelid margin findings in this study may be due to several reasons. First, the timing and duration of lid hygiene differed from previous reports. For instance, in a previous study, lid hygiene was performed for 10 days, from 3 days prior to cataract surgery to one week postoperatively.[7] In this study, patients were instructed to not wipe their eyelids before cataract surgery but start wiping their eyelids one week after surgery until approximately four weeks postoperatively. For the first week after surgery, patients were prohibited from washing their face to prevent postoperative infection, and therefore, lid hygiene was initiated when MGD was supposedly worsened. Consequently, the effect of lid hygiene on the eyelid margin may be limited. Second, there is a possibility that patients in the lid hygiene group did not wipe their eyelid properly. Although we provided an instruction leaflet with a schema showing the eyelid cleaning method, it is possible patients did not wipe the eyelid margin and instead wiped areas around the eyelid margin. In addition, it was reported that only 55% of patients were able to maintain lid hygiene for six weeks after commencing, suggesting patients did not adhere to this study well.[24] Furthermore, in a previous study,[7] postoperative BUT was significantly longer in the lid hygiene group than in the control group, whereas in this study, it was significantly shorter in the lid hygiene group. This conflicting result may be due to the same reasons that the eyelid margin findings were not significantly different between the two groups, as described above, and due to modification of the postoperative eyedrops (antibiotics, steroid and anti-inflammatory eyedrops). This would also explain why there were no differences in SPEED and SPK score changes between the two groups. Nevertheless, the current study was noteworthy since significant effects of lid hygiene were successfully detected in a randomized control design. The differences in sex ratio, nutrition and lifestyle between the two groups might be other contributing factors.

There are several limitations to this study. First, the sample size was small, and there were preoperative differences between the two groups in some eyelid margin findings, such as meibo score and dropout. Therefore, it might be difficult to observe significant changes postoperatively even with the implementation of lid hygiene and it is possible that a higher prevalence of pre-existing eye disease in the eyelid hygiene group could impact postoperative outcomes. Further study would clarify if MGD severity should be adjusted for between the two groups. Second, as mentioned earlier, the timing and duration of lid hygiene is debatable. Greater lid hygiene before surgery would potentially contribute to a greater effect of lid hygiene following ocular surface examination. In addition, the postoperative evaluation of FVA and HOA one month after surgery should be longer. Extending this evaluation to at least three months post-surgery would be better based on the post-operative instability of HOAs, manifest refraction, FVA and the healing process after the cataract surgery. Third, there is a concern around incomplete lid wiping despite preoperative instruction. This could have been circumvented if patients had been encouraged to refer to these instructions throughout the study and potentially use a check sheet to confirm proper lid hygiene and instillation of ophthalmic solutions during the postoperative period.

Conclusions

Lid hygiene after cataract surgery significantly improved the visual maintenance ratio of FVA and reduced the deterioration of HOA compared with the control group. The current results suggest that postoperative lid hygiene is effective in improving visual function.

Abbreviations

BUT, tear film break-up time; FVA, functional visual acuity; HOA, higher-order aberration; logMAR, logarithm of the minimum angle of resolution; MGD, meibomian gland dysfunction; OSD, ocular surface disease; SPK, superficial punctate keratopathy; SPEED, Standard Patient Evaluation of Eye Dryness.

Availability of Data and Materials

The data sets created or analyzed during this study are not publicly accessible due to the confidentiality of patient information. However, they can be obtained from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

The study protocol was approved by the institutional review board of the University of Keio. Written informed consent was obtained from each patient participating in the study. In accordance with the provisions of the Declaration of Helsinki (1995), approval was obtained from the Ethics Committee of the Keio University School of Medicine (approved on 8 July 2020, reference 20190131).

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Disclosure

None of the authors have any conflicts of interest in this work.

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