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Research Article

Effects of Central Corneal Thickness on Early Postoperative Corneal Edema after Phacoemulsification

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Keywords

- Central corneal thickness
- Early postoperative corneal edema
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Abstract

Purpose: To assess the effects of central corneal thickness (CCT) on early postoperative corneal edema (EPCE) after phacoemulsification in patients with healthy corneas.

Methods: Sixty-six eyes (44 patients) without evident corneal endothelial pathology that had phacoemulsification were included retrospectively and divided into a thick CCT group (preoperative CCT ≥580 μm; 15 eyes) and a control group (preoperative CCT <580 μm; 51 eyes). Endothelial cell density (ECD) and CCT were measured preoperatively and 1 month postoperatively. Primary outcome measurements were endothelial cell loss (ECL, %) and CCT change (%). We also evaluated the effect of patient factors (age, CCT, anterior chamber depth [ACD], ECD) and surgical factor (cumulative dissipated energy [CDE]) on EPCE.

Results: The intergroup differences in CCT change (1.6% in thick CCT group vs. 2.9% in control group, P = 0.170) and ECL (-11.8% in thick CCT group vs. -9.1% in control group, P = 0.701) were not significant. The ECL and CCT change showed no significant correlations with age, CCT, ACD, or CDE (P > 0.05). The CCT change had no correlation with preoperative ECD (P = 0.934), however, the ECL and preoperative ECD had a negative correlation (r = -0.602, P < 0.001).

Conclusion: Thick preoperative CCT (≥580 μm) does not increase the risk of EPCE in patients with otherwise healthy corneas.

ABBREVIATIONS

ACD: Anterior Chamber Depth; CCT: Central Corneal Thickness; CDE: Cumulative Dissipated Energy; CV: Coefficient Variance; ECD: Endothelial Cell Density; ECL: Eendothelial Cell Loss; EPCE: Early Postoperative Corneal Edema; IOL: Intraocular Lens

INTRODUCTION

The development of phacoemulsification surgery has resulted in a trend towards improved visual acuity with optimal safety and minimum invasiveness [1,2]. Patient expectations have increased in conjunction with this trend, therefore faster recovery of visual acuity after the phacoemulsification has become more important.

Early postoperative corneal edema (EPCE) is a one of the significant clinical factors hindering early visual recovery [3]. Cornea swelling increases light back-scattering, which results in reduction of contrast sensitivity and increased susceptibility to glare [4]. A boost in the volume of premium intraocular lens (IOL) also demands postoperative optical clarity to achieve maximum clinical outcomes. Recent designs of multifocal IOLs induce more light scattering than monofocal IOLs, thus patients with high risk of postoperative corneal edema would not be good candidates for these IOLs [5,6].

Preexisting corneal endothelial dysfunction is a well-known factor of postoperative corneal edema [7]. In routine cataract surgery, preoperative corneal endothelial function is evaluated by endothelial cell density.Low endothelial cell density (ECD) below 600 to 800 cells/mm^{2}is known as a risk factor of corneal decompensation except in patients who have extremely low ECD. Although there is large variation in normal corneal thickness, central corneal thickness (CCT) increases with corneal swelling and is used as an indicator of corneal edema. Previous studies reported that CCT is a significant predictor of postoperative corneal decompensation in patients with Fuchs' dystrophy [8,9]. Yet there is lack of evidence whether thick CCT in otherwise healthy cornea is a risk factor for EPCE.

The aim of this study was to determine the effect of CCT on EPCE after phacoemulsification in patients without any corneal pathology.

MATERIALS AND METHODS

Patients

We reviewed the medical records of patients with cataracts who underwent phacoemulsification and intraocular lens implantation at the Seoul National University Bundang Hospital between November 2014 and February 2015. Patients were excluded from the study if they had clinical corneal pathology such as Fuchs' dystrophy, if they had less than 2000/mm^2 of ECD. The tenets of the Declaration of Helsinki were followed, and the study was approved by the Insititutional Review Board (IRB) of Seoul National University Bundang Hospital (IRB number: B-1508/312-109) and written informed consent was waived by IRB because the data were collected retrospectively and analyzed anonymously.

Preoperative Evaluation

The preoperative data collected included age, gender, CCT, anterior chamber depth (ACD), ECD, coefficient variance (CV), and hexagonality. CCT and ACD were measured by an experienced ophthalmic technician using Orbscan II Corneal Topography System (Bausch & Lomb, Rochester, NY, USA). ECD, CV, and hexagonality were measured by specular microscopy (Noncon ROBO SP-8800; Konan Medical, Nishinomiya, Japan).

Surgical Technique

Phacoemulsification was performed by a single experienced surgeon (JYH) with the Infiniti Vision System (Alcon Laboratories, Inc., Fort Worth, TX) using a standardized technique (phaco-chop). A 2.2-mm–wide clear corneal incision was fashioned, and a continuous curvilinear capsulorrhexis was made using forceps. The nucleus was hydrodissected and phacoemulsified. Balanced salt solution was used as an irrigation solution and DisCoVisc (Alcon Laboratories, Inc., Fort Worth, TX) was used as an ophthalmic viscosurgical device. Cumulative dissipated energy (CDE) was measured intraoperatively.

Postoperative Evaluation

At postoperative 1 month, CCT, ACD, ECD, CV, and hexagonality were evaluated. Endothelial cell loss (ECL) was calculated as follows: ECL (%) = [(postoperative ECD – preoperative ECD)/ preoperative ECD] × 100. The CCT change was calculated as follows: CCT change (%) = [(postoperative CCT – preoperative CCT)/preoperative CCT] × 100.

Statistical Analysis

Statistical analysis was performed using SPSS for Windows (version 22.0, SPSS, Inc., Chicago, Illinois). The statistical tests were conducted at a level of $p < 0.05$. Differences in the percentage of the ECL and CCT changes were compared between the thick CCT group and the control group using the Mann–Whitney U test; demographic data were compared using Pearson Chi-square test. Patient factors (age, CCT, ACD, ECD) and a surgical factor (CDE) were assessed as possible factors of EPCE by Pearson correlation test.

RESULTS AND DISCUSSION

Demographics, preoperative and intraoperative data

Preoperative patient demographics are summarized in Table 1. Mean CCT was 609.8 μm ± 10.9 (SD) in the thick CCT group and 538.8 μm ± 26.5 (SD) in the control group ($P < 0.001$, Independent *t*-test). There were no other significant differences between two groups for age, gender, ACD, ECD, CV, hexagonality, or CDE (all $P > 0.05$).

Comparison of ECL (%) and CCT changes (%) between two groups

There were no statistically significant differences in ECL or CCT between the thick CCT group and the control group (Table 2). The mean ECL was -11.8% ± 13.7 (SD) in the thick CCT group, and -9.1% ± 14.2 (SD) in the control group (P = 0.520, Mann–Whitney U test). The CCT change was 1.6% ± 4.2 (SD) in the thick CCT group, and 2.9% ± 4.4 (SD in the control group (P = 0.288, Mann–Whitney U test).

Correlation between ECL and CCT change and Possible Preoperative and Intraoperative Factors

As we evaluated the correlations between postoperative ECL or CCT changes and possible factors of EPCE of the total population using a univariate correlation test (Table 3), we found that lower preoperative ECD was associated with lessened ECL (r = -0.544; $P < 0.001$, Figure 1). However, the CCT change had no correlation with preoperative ECD (P = 0.934). The postoperative ECL and CCT change showed no significant correlations with age, preoperative CCT, ACD, CV, hexagonality, and CDE ($P > 0.05$).

CONCLUSION

It is well known fact that the risk of corneal decompensation and corneal edema increases when the ECD level drops below 600 to 800 cells/mm^2. Several studies have focused on the relationship between preoperative CCT and corneal decompensation after phacoemulsification in patients with compromised corneal endothelium such as Fuchs' dystrophy [8,9]. Seitzman et al. [8], suggested that many patients with Fuch's dystrophy whose CCT is less than 640 μm can undergo cataract surgery without postoperative corneal decompensation. Doors et al. [9], reported that preoperative CCT was the only significant predictor of postoperative corneal decompensation in patients with Fuchs' dystrophy and they showed that CCT greater than 620 μm could lead to increased risk for corneal decompensation after phacoemulsification. These studies imply that CCT could be used as an index for endothelial cell function when considering the phacoemulsification procedure in patients with Fuchs' dystrophy.

When the patients have thick CCT and otherwise normal looking cornea, they might have suboptimal corneal endothelial function even though there is no noticeable change in the endothelium. However, to our knowledge, there is no report about

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Table 1: Demographic characteristics and preoperative and intraoperative data of the two groups.

	Thick CCT group	Control group	Total	P value*
Number	15	51	66	
Age, y	71.7 (11.2)	67.6 (11.9)	68.5 (11.8)	0.242
M:F	5:10	29:22	34:32	0.109†
CCT, µm	609.8 (10.9)	538.8 (26.5)	554.9 (38.3)	< 0.001
ACD, mm	2.5 (0.4)	2.6 (0.4)	2.5 (0.4)	0.530
ECD, cells/mm^2	2647.0 (387.7)	2648.2 (361.8)	2648.0 (364.8)	0.991
CV,	34.1 (8.2)	34.1 (6.9)	34.1 (7.2)	0.999
Hexagonality	56.8 (9.2)	54.0 (14.3)	54.7 (13.3)	0.378
CDE	6.0 (2.9)	6.5 (5.7)	6.4 (5.2)	0.732

Abbreviations: ACD: Anterior Chamber Depth; CCT: Central Corneal Thickness; CDE: Cumulative Dissipated Energy; CV: Coefficient Variance; ECD: Endothelial Cell Density
Data are expressed as mean (SD)
*Mann-Whitney U test
†Pearson Chai-square test

Table 2: Endothelial cell loss and change of central corneal thickness in two groups.

	Thick CCT group	Control group	P value*
Number	15	51	
Endothelial cell loss (%)	-11.8 ± 13.7	-9.1 ± 14.2	0.520
Preoperative ECD (cells/mm^2)	2647.0 ± 387.7	2648.2 ± 361.8	0.991
Postoperative ECD (cells/mm^2)	2315.9 ± 371.8	2377.7 ± 314.7	0.523
CCT change (%)	1.6 ± 4.2	2.9 ± 4.4	0.288
Preoperative CCT (µm)	609.8 ± 10.9	538.8 ± 26.5	< 0.001
Postoperative CCT (µm)	619.1 ± 24.4	554.4 ± 35.1	< 0.001

Abbreviations: CCT: Central Corneal Thickness; ECD: Endothelial Cell Density
Data are expressed as mean ± standard deviation.
*Mann-Whitney U test

Table 3: Univariate association using Pearson correlation coefficient of patients' factors and surgical factor with endothelial cell loss (%) and central corneal thickness change (%).

	Endothelial cell loss (%)		CCT change (%)	
	Correlation coefficient	*P value	Correlation coefficient	*P value
Age	-0.190	0.126	-0.081	0.517
CCT	-0.080	0.522	-0.146	0.242
ACD	0.230	0.063	-0.042	0.740
ECD	-0.544	< 0.001	0.010	0.934
CV	-0.026	0.838	-0.044	0.723
Hexagonality	0.029	0.818	-0.015	0.907
CDE	-0.111	0.386	0.071	0.580

Abbreviations: ACD: Anterior Chamber Depth; CCT: Central Corneal Thickness; CDE: Cumulative Dissipated Energy; CV: Coefficient Variance; ECD: Endothelial Cell Density
*Pearson correlation test

EPCE in subjects with thick CCT without any clinical endothelial disease. In patients without overt endothelial abnormality, there would be little risk of corneal decompensation after uneventful phacoemulsification. However, transient EPCE from decreased endothelial function may impede fast recovery of best attainable vision, leads to patients' dissatisfaction.

We evaluated the factors that affect EPCE after phacoemulsification, especially about the influence of preoperative CCT on EPCE to examine the EPCE in patients with subnormal range of CCT (≥580 µm). The results showed that the ECL and the CCT change were not significantly different between the two groups, although ECL was greater in the thick CCT group and the CCT change was greater in control group. The results in the present study suggest that the risk of EPCE does not increase in patients who have corneal thickness of ≥580 µm without any endothelial disease. In the literatures, normal CCT measured by Orbscan II is known to be 535.8~547.6 µm [10-12]. Considering the reported standard deviation of the measurements, we classified patients who had CCT equal to or greater than 580 µm as a thick CCT group.

Previous studies about correlation between age and CCT have produced inconsistent results. Cosar et al. [13], reported that corneal thickness increases with age, while Galgauskas et al. [14], recently reported that CCT decreases over the lifetime. Our

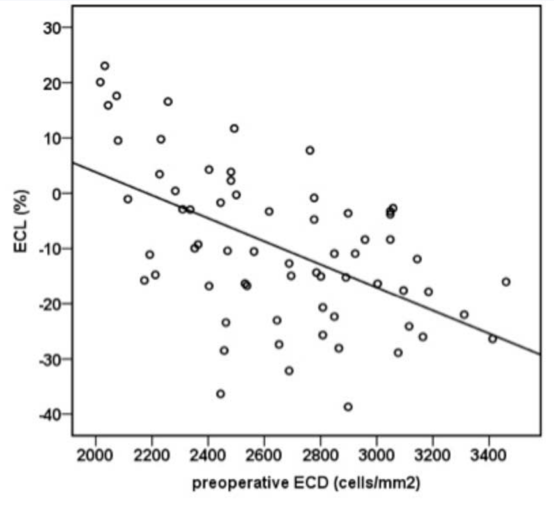

Figure 1 Scatterplot of relationship between the preoperative endothelial cell density and the endothelial cell loss at 1 month postoperatively (Pearson Correlation Coefficient, r=-0.544; p < 0.001).

data showed that age and preoperative CCT have no significant correlation, even though they tended to increase with age. In this study, the mean ECL was approximately 11.8% in thick CCT group and 9.1% in control group. The result was similar to those of other studies reporting 1.8% to 15.0% of ECL after phacoemulsification in eyes with a normal preoperative ECD [15-18].

Old age [19], high ultrasound energy [16,20], and short axial length [21] are associated with an increased risk for endothelial cell damage. Recently, Reuschel et al. [22], evaluated influence of anatomical risk factors such as ACD, anterior chamber volume, lens density and axial length. They reported that none of them were identified as risk factors of postoperative endothelial cell loss. Some previous studies found that the preoperative ECD was not predictive of corneal endothelial cell loss in eyes with a normal ECD [16, 18]. In this study, age, CCT, ACD, CV, hexagonality, and intraoperative CDE were not associated with postoperative ECL and CCT change. However, we found a lower preoperative ECD was associated with reduced ECL. This suggests that patients with relatively low ECD could be expected to have relatively less ECL. However, this result must be interpreted with cautious, as we only included patients without any corneal endothelial pathology.

Our study has some limitations. First, there were no cases with complication. If the cases with longer surgical time or intraoperative complications were included, there might be differences between the thick CCT group and the control groups. Second, we evaluated corneal thickness with Orbscan system, which is only one of many options for measuring corneal thickness. There would be error in determining the representative values from each device. Third, number of patients in thick CCT group is relatively small compare to the control group.

In conclusion, the preoperative thick CCT does not affect EPCE after phacoemulsification in patients who do not have evident clinical endothelial diseases. Older patients with thick CCT without any corneal endothelial pathology may not be concerned with EPCE.

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