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ORIGINAL PAPER

Central corneal epithelial thickness changes after half-moon supracapsular nucleofractis phacoemulsification technique

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Abstract
Purpose To find out the effect of half-moon supracapsular nucleofractis technique on central corneal epithelial thickness (CET) measured by spectral domain anterior segment optical coherence tomography (AS-OCT).
Materials and methods Patients who underwent uneventful cataract surgery by the same surgeon with the same technique were recruited in this study. The effective phaco time (EPT) was recorded in each surgery. Central CET was measured by AS-OCT 1 day before and 1, 3, 7 days after surgery. CET was measured without precorneal tear film layer, and non-epithelial central corneal thickness was also calculated manually. Preoperative and postoperative values were compared by statistical analysis.
Results Thirty-one eyes of 31 patients were included in this study. The mean age of patients was 65.03 ± 11.47 years. On the first day of surgery, increase in mean CET was statistically significant, but on the 3rd and 7th day after surgery, this increase was declined ($p = 0.001, p = 0.367, p = 1$, respectively). A statistically significant positive correlation was found between mean EPT and mean CET on the first postoperative day ($p = 0.013$, $r = 0.470$). On the 3rd and 7th day, this correlation was not statistically significant ($p = 0.055$, $p = 0.454$, respectively).
Conclusion Mean central CET was statistically thicker and positive correlated with EPT on the first postoperative day. But on the 7th day, it declined to preoperative values.

Keywords Corneal epithelial thickness · Half-moon supracapsular nucleofractis technique · Cataract surgery

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Introduction

Cataract surgery has been performed to improve visual acuity for many years, and phacoemulsification technique is one of the safest and effective techniques used widely for this surgery all around the world. Although this procedure restores visual dysfunction, it has adverse effects on the ocular surface. Reduction in corneal sensitivity, tear film instability, often temporary, rarely permanent corneal edema due to corneal endothelial cell loss are most known side effects [1–3]. There have been various nucleofractis phacoemulsification techniques described before, and half-moon supracapsular (HMSC) nucleofractis technique is one of them [4–6]. Safety, efficacy and functionality of this

technique had been compared with stop and chop technique. Mean time of operation, effective phacoemulsification time (EPT) and phacopower were found statistically lower in cases which were performed with HMSC technique. On the other hand, mean central corneal thickness (CCT) was found statistically higher 1 day after operation. This increase did not continue during follow-up time [5]. Lundberg et al. [7] previously reported that the increase in CCT on the first postoperative day directly correlated with surgical trauma to the endothelium.

Increase in mean CCT due to phacoemulsification ultrasound energy is well known. There are few studies which evaluated corneal epithelial thickness (CET) changes after cataract surgery [8–13]whereas significant changes in CET have been found to correlate with corneal instability [14]. To reveal the damage to corneal epithelium, several imaging techniques such as ultrasound biomicroscopy, in vivo confocal microscopy and several tests such as impression cytology have been used [15–17]. Spectral domain anterior segment optical coherence tomography (AS-OCT) is preferred for evaluating corneal epithelium in several studies because of its great reliability and repeatability [18, 19].

In our study, we aimed to find out the effect of the HMSC nucleofractis technique on central CET measured by spectral domain AS-OCT during the first week after surgery. The second objective of our study is to investigate the correlation between central CET and EPT.

Materials and methods

This study was conducted at the Department of ophthalmology. Prior approval from the Institutional Review Board was taken, and written informed consent was obtained from each subject. The study was performed in adherence to the Declaration of Helsinki.

Patients who underwent uneventful cataract surgery were recruited in this study. Full ophthalmic examination, including best corrected visual acuity, intraocular pressure (IOP) measurement by non-contact tonometry, biomicroscopic and funduscopic evaluation, was performed before and 1, 3 and 7 days after surgery. Patients with 20 mmHg and higher IOP measurements after surgery, meibomian gland disease, any other ocular disease except senile cataract, any topical medication use, and systemic diseases except primer hypertension were not included in this study.

Cirrus EDI-OCT (Carl Zeiss Meditec, Dublin, CA, USA) was used to obtain high-resolution anterior segment scans (5 μ axial resolution). Scans with signal strength of ≥ 8 were used for analysis. Scans with misalignment and poor illumination or those out of focus were also excluded. Measurements were done 1 day before surgery, in the first, third and seventh day after surgery. Central corneal epithelial thickness was measured manually in five different places of each scan, and the average value was calculated. Only CET was measured without precorneal tear film layer. Non-epithelial central corneal thickness (NCCT) was also calculated manually.

All surgeries were performed by the same surgeon (SÖ). Prior to the operation, tropicamide 1% (Tropamid, Bilim, Turkey) and phenylephrine hydrochloride 2.5% (Mydfrin, Alcon, USA) were instilled for adequate pupil dilation. Proparacaine HCl 0.5% was used for topical anesthesia in all surgeries. Eyelids, eyelashes and conjunctiva were disinfected with povidone-iodine 5%. A clear corneal incision was done with a 2.8-mm slit knife. One type of dispersive (Viscoat, Alcon) and cohesive (Healon, Abbott) viscoelastics were used in all surgeries. After anterior camera was extended with dispersive viscoelastic, a continuous curvilinear capsulorhexis with a diameter of approximately 5.0 mm was done. After hydrodissection, phacoemulsification was performed with the HMSC nucleofractis technique which was defined by Can et al. [5]. One-piece hydrophobic acrylic posterior chamber intraocular lens (PCIOL) (Sensar, AMO, AAB00) was implanted into the capsular bag in all surgeries. All operations were concluded with intracamaral moxifloxacin 0.5%/0.1 cc. The EPT was recorded from the data panel of the phacoemulsification instrument. All patients were treated with topical moxifloxacin 0.5% four times a day and dexamethasone 0.1% eight times on the first day after the operation and four times a day in the first week after the operation. Topical medications except these two drops were not used.

A one-way repeated measures ANOVA was conducted to compare the effect of half-moon supracapsular (HMSC) nucleofractis technique on central corneal epithelial thickness (CET) measured by

spectral domain anterior segment optical coherence tomography (AS-OCT), preoperative, 1st, 3rd and 7th day after surgery. The p value less than 0.05 was considered to be significant.

Results

Thirty-one eyes of 31 patients were included in this study. The mean age of patients was 65.03 ± 11.47 years. Table 1 reveals changes in mean CCT, central CET and NCCT before and 1, 3 and 7 days after surgery. The differences in mean CCT and in mean NCCT between preoperative and 1, 3 and 7 days after surgery were statistically significant. On the first day after surgery, increase in mean CET was statistically significant, but on the 3rd and 7th day after surgery, this increase was declined (Table 2).

The second objective of our study was to investigate a correlation between mean EPT and mean CET. A statistically significant positive correlation was found between mean EPT and mean CET on the first postoperative day ($p = 0.013$, $r = 0.470$). On the 3rd and 7th day after the operation, this correlation was not statistically significant ($p = 0.055$, $p = 0.454$, respectively) (Table 3). Besides, there were statistically significant positive correlations between mean CCT and mean EPT on the 1st and 3rd day after surgery ($p = 0.043$, $p = 0.035$, respectively).

Discussion

CCT can be affected after cataract surgery, depending on the technique, instrumentation, use of protective viscoelastic material, drugs and the irrigating solution

Table 1 Results of corneal parameters preoperatively, 1, 3 and 7 days after cataract surgery

	Preoperative	Postoperative 1st day	Postoperative 3rd day	Postoperative 7th day
CCT (μm)	520.06 ± 36.05	703.41 ± 169.75	638.51 ± 157.08	566.51 ± 88.1
CCET (μm)	46.12 ± 3.86	50.60 ± 5.98	48.38 ± 5.45	46.58 ± 3.90
NECCT (μm)	469.09 ± 35.53	650.19 ± 176.11	584.29 ± 153.21	515.54 ± 86.31

CCT central corneal thickness, *CCET* central corneal epithelial thickness, *NECCT* non-epithelial central corneal thickness

Table 2 Statistical analysis of CCT, CCET and NECCT

	Preoperative–postoperative 1st day	Preoperative–postoperative 3rd day	Preoperative–postoperative 7th day
CCT (μm)	$p < 0.001$	$p < 0.001$	$p = 0.012$
CCET (μm)	$p = 0.001$	$p = 0.367$	$p = 1.000$
NECCT (μm)	$p < 0.001$	$p < 0.001$	$p = 0.010$

Comparison of preoperative values and the values in the first, third and seventh day of surgery

CCT central corneal thickness, *CCET* central corneal epithelial thickness, *NECCT* non-epithelial central corneal thickness

Table 3 Correlations between mean CET and mean EPT

	Mean CET (μm)	Mean EPT	r	p
On the 1st day of surgery	50.64 ± 5.9	17.06 ± 12.9	0.470	**0.013**
On the 3rd day of surgery	48.38 ± 5.4	17.06 ± 12.9	0.373	0.055
On the 7th day of surgery	46.5 ± 3.9	17.06 ± 12.9	0.150	0.454

The bold reflected p value is statistically significant

CET corneal epithelial thickness, *EPT* effective phaco time

used. In cataract surgery, the most important factors that affect the clarity of cornea in postoperative period are phacoemulsification technique and ultrasound energy. Up to now various phacoemulsification techniques have been developed and modified. In our study, we aimed to evaluate the effect of the HMSC nucleofractis technique which was defined by Can et al. [5]. In this technique, the beginning of the nucleus chopping is performed closer to the endothelium. Because of this, corneal endothelium was found to be effected more when compared with Nagahara chop technique. This result was detected by measuring mean CCT before and after surgery. In the first week of cataract surgery, mean CCT was found significantly higher when compared with Nagahara chop technique [5]. As a result of a few recent studies, mean CET was also found effected, especially in the first week after cataract surgery [11–13]. Kanellopoulos et al. [13] reported that mean CET was statistically thicker on the first postoperative day, but in the first week there was no statistical difference between preoperative and postoperative measurements. Zheng et al. reported that in the first 3 days after operation, mean CET was statistically thicker, but 5 and 7 days postoperatively, it was thinner than preoperative values.

In our study, we found that in the first day after surgery, mean CET was statistically thicker and in the first week, it declined to preoperative values. Preoperative mechanical injuries, drugs applied to the ocular surface during surgery, eyedrops, which were used postoperatively and just the surgery itself can cause inflammation and corneal epithelial cell instability. This instability seems to normalize in the first week of the cataract surgery while the recovery time for whole cornea is much longer. In previous studies, phacoemulsification technique was not specialized. In our study, we specialized the phacoemulsification technique and chose HMSC technique because the central cornea had been already found to be affected more in the first week of the surgery.

We measured mean CET by using spectral domain AS-OCT. AS-OCT is a non-contact procedure and is user friendly. High-definition images obtained by AS-OCT allow the practitioner to visualize the epithelium, stroma and endothelium with clear differentiation. Zheng et al. [11] measured precorneal tear film layer and epithelial thickness together. This might be the cause of different results between this study and our study, we manually measured only central epithelial thickness.

The second objective of our study was to investigate a correlation between mean EPT and mean CET. Statistically, significant positive correlation was found between EPT and mean CET on the first postoperative day. Zheng et al. also found a statistically significant correlation between phacopower, ultrasound total time and mean CET.

The limitations of our study were relatively small sample size, only central 5 mm central measurements of epithelial thickness. Besides, we investigated only HMSC technique, not compared with another technique. Further long-term detailed studies with larger sample size should be done to better define the effects of the phacoemulsification technique on central CET.

In conclusion mean CET was statistically thicker and positive correlated with EPT on the first postoperative day. But in the first week, it did not differ from baseline measurement.

Compliance with ethical standards

Conflict of interest All the authors declare that they have no conflicts of interest.

Ethical approval Human participants in this study were in accordance with the ethical standards of Institutional Research Committee.

Informed consent Informed consent was obtained from all subjects in this study. The study was performed in adherence to the 1964 Declaration of Helsinki.

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