Corneal endothelial cell loss after phacoemulsification versus extracapsular cataract extraction in management of senile cataract

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Purpose
To compare the corneal endothelial cell density and morphology in early postoperative period after phacoemulsification and extracapsular cataract extraction (ECCE) in management of senile cataract.

Design
This is a prospective, nonrandomized clinical interventional case study.

Setting
The study was conducted at the Department of Ophthalmology, Assiut University, Egypt.

Patients and methods
This study included 70 eyes of 70 patients with uneventful senile cataract that were divided into two groups. Group I included 35 eyes with nuclear hardness up to grade IV (LOCS III) and underwent standard phacoemulsification. Group II included 35 eyes with nuclear hardness of grades V and VI and underwent conventional ECCE. In all cases, specular microscopy (NIDEK CEM 530) was done preoperatively and 1 month postoperatively.

Results
The preoperative mean ± SD endothelial cell count in group I was 2372 ± 379, whereas in group II was 2313 ± 335. In each group, there was a statistically significant decline in endothelial cell density after 1 month. The mean ± SD endothelial cell count 1 month postoperatively in group I was 2106 ± 344, whereas in group II was 2030 ± 295. There was no statistically significant difference in overall percentage of endothelial cell loss between the two groups. The coefficient of variation and endothelial cell hexagonality were significantly changed 1 month postoperatively in each group with no significant difference between them.

Conclusion
The adverse effect of phacoemulsification on the corneal endothelial cells when it is performed for senile cataract with nuclear hardness up to grade IV is nearly similar to that caused by ECCE when it is done for cataract with nuclear hardness of grades V and VI.

Keywords:
Cataract, endothelium, specular microscopy

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Introduction

Age-related cataract is considered the chief cause of treatable blindness all over the world. Although cataract is treatable and the rate of cataract surgeries has being increased, it is still the main cause of blindness and visual disability worldwide. Population-based studies and previous meta-analyses which were performed all over the world have reported that cataract alone is responsible for 47.8–51% of all global blindness [1–3]. For this reason, many advances were introduced to cataract surgery to obtain early visual rehabilitation and good visual outcome. These included the shift from intracapsular cataract extraction to extracapsular cataract extraction (ECCE), the advent of intraocular lens (IOL) implantation and viscoelastic materials, manual small-incision cataract surgery, phacoemulsification, and the most recent femtosecond laser-assisted cataract surgery. Among the most important factors that affect the visual outcome is the effect of these different surgical techniques on the corneal endothelium [4,5].

The corneal endothelium functions as a barrier through its tight cell junction and active fluid pump system to maintain corneal transparency and normal function. The corneal endothelium in human is a monolayer of cells with limited regeneration capacity. The endothelium heals itself by cell enlargement and migration. Thus, any damage to the endothelium affects

its function and its ability to withstand further injury. When endothelial cell density significantly decreases, corneal edema may develop, which can be extremely severe leading to corneal decompensation [6]. Surgical trauma can accelerate normal age-related corneal endothelial cell loss (ECL). Some ECL is accepted after uncomplicated cataract surgery, and it has been reported to vary from 4 to 25% [4,5]. Several studies were conducted to evaluate the effect of different cataract surgical techniques on the corneal endothelium [7–14].

In the literature, studies were conducted to estimate corneal ECL after phacoemulsification compared with after ECCE [9–11].

Patients and methods

After approval of the ethical committee of Faculty of Medicine, Assiut University according to the ethical principles outlined in the Declaration of Helsinki (approval number 17100295), the author conducted this prospective, nonrandomized, clinical interventional case study in the Department of Ophthalmology, Assiut University. This study was carried out between October 2017 and August 2019 and included 70 eyes of 70 patients with senile cataract. Any case with corneal endothelial pathology, previous ocular surgery, coexistent ocular pathology, or associated with operative complications was excluded. Preoperative specular microscopy (NIDEK CEM 530 [made in Japan]) was done for all cases, and data for central corneal endothelial cell density, coefficient of variation (CV), and hexagonal cells (HEX) were taken after exclusion of cases with abnormal specular parameters.

The patients were divided into two groups of 35 patients each. Phacoemulsification using Oertli machine (AG Hafnerwisenstrass 4 CH-9442 Berneck, Switzerland) was done to group I (up to grade IV LOCS III) through 2.8-mm corneal incision. A continuous curvilinear capsulorhexis was done, and hydro-dissection was done using Ringer's lactate solution. Removal of the nucleus was done by stop and chop technique with phaco tip up, pulse mode, duty cycle 50%, aspiration flow rate (20 ml/min), phaco power: phaco I 70%, and phaco II 50%. A 6.5-mm hydrophobic acrylic single-piece foldable IOL was implanted in capsular bag. Group II with cataract (grades V and VI) underwent ECCE through 9–11-mm corneal incision. The nucleus was expressed by a lens loop. A 6.5-mm PMMA IOL was implanted in capsular bag. In both techniques, the viscoelastic substance was methyl cellulose and manual irrigation aspiration with Ringer's lactate solution was used for removal of cortical matter and viscoelastic. All operations were done by a single expert surgeon.

Specular microscopy (NIDEK CEM 530) was done for all cases 1 month postoperatively, and data for central corneal endothelial cell count, CV, and HEX were taken. Data were collected and entered on Microsoft access data to be analyzed using the statistical package for the social sciences (version 16; SPSS Inc., Chicago, Illinois, USA). Comparison between the two groups was done using different statistical tests that allowed comparing the dichotomous and ordinal variables in the groups.

Results

Table 1 summarizes the demographic data of the two studied groups. Each group included 35 eyes of 35 patients, and the age of patients was between 60 and 70 years. Mean age in group I was 64.03 years, whereas in group II was 65.86 years, with no statistically significant difference. No statistically significant difference was found between the two groups regarding sex.

The descriptive data on endothelial cell count preoperatively and 1 month postoperatively of the two studied groups are shown in Table 2. The preoperative mean ± SD endothelial cell count in group I was 2372.51 ± 379.03, whereas in group II was 2313.34 ± 335.17 with no statistically significant difference ($P = 0.49$).

The 1-month postoperative mean ± SD endothelial cell count in group I was 2106.46 ± 344.53, whereas

Table 1 Demographic data of the studied groups

	Group I (*n*=35)	Group II (*n*=35)	*P*
Age (years)			
Mean±SD	64.03±3.39	65.86±3.39	0.310
Range	60.0-70.0	60.0-70.0	
Sex [*n* (%)]			
Male	20 (57.1)	18 (51.4)	0.631
Female	15 (42.9)	17 (48.6)	

Independent samples *t* test. χ^2 test.

Table 2 Endothelial cell count in the studied groups preoperatively and 1 month postoperatively

Endothelial cell count	Group I (*n*=35)	Group II (*n*=35)	*P*[1]
Preoperative			
Mean±SD	2372.51±379.03	2313.34±335.17	0.491
Range	1761.0-3205.0	1722.0-2957.0	
1-month postoperative			
Mean±SD	2106.46±344.53	2030.20±295.13	0.324
Range	1554.0-2951.0	1534.0-2659.0	
P[2]	0.000*	0.000*	

1: Independent samples *t* test. 2: Paired samples *t* test. *P=0.05

in group II was 2030.20 ± 295.13, with no statistically significant difference (P = 0.324). However, in each group, there was a statistically significant decline in endothelial cell density after 1 month postoperatively. One month postoperatively, the percent of ECL in group I was 10.9%, whereas in group II was 11.7%, with no statistically significant difference in the two groups (Table 3).

The endothelial cell size represented by CV was significantly increased 1 month postoperatively in each group, with no statistically significant difference between them (Table 4). The hexagonality of endothelial cells significantly decreased 1 month postoperatively in each group, with no statistically significant difference between them (Table 5).

Discussion

For many years, cataract surgical techniques showed many advances to improve visual outcomes and rehabilitation. The effect of any surgical technique on corneal endothelium was of great concern among studies because it reflects safety of the technique and directly affects the postoperative visual outcomes and patient satisfaction [4,5].

Table 3 Percent of endothelial cell loss in the studied groups during postoperative follow up period

	Group I (*n*=35)	Group II (*n*=35)	*P*
1-month % of ECL			
Range	2.9-13.8	5.6-26.9	0.103
Median	10.9	11.7	

Mann-Whitney test. ECL, endothelial cell loss.

Table 4 Coefficient of variation in the studied groups

CV	Group I (*n*=35)	Group II (*n*=35)	*P*[1]
Preoperative			
Mean±SD	29.60±1.96	28.89±2.30	0.166
Range	24.0-32.0	24.0-35.0	
1-month postoperative			
Mean±SD	33.17±2.38	33.11±2.86	0.928
Range	28.0-37.0	29.0-40.0	
P[2]	0.000*	0.000*	

1: Independent samples *t* test. 2: Paired samples *t* test.
CV, coefficient of variation. *P=0.05

Table 5 Hexagonality in the studied groups

Hexagonality	Group I (*n*=35)	Group II (*n*=35)	*P*[1]
Preoperatively			
Mean±SD	66.71±3.42	66.69±3.12	0.971
Range	60.0-78.0	60.0-71.0	
1-month postoperatively			
Mean±SD	62.63±3.56	63.97±3.65	0.124
Range	57.0-69.0	55.0-69.0	
P[2]	0.000*	0.000*	

1: Independent samples *t* test. 2: Paired samples *t* test. *P=0.05

It is known that the more the surgical trauma to the endothelium, the more the ECL. That is why the accuracy and proper selection of the surgical technique are essential in reducing endothelial damage. In the past, phacoemulsification was considered to be more harmful to the corneal endothelium than ECCE [8].

In the literature, some studies were conducted to compare the effect of both phacoemulsification and ECCE on endothelial cell count. All of these studies reported significant ECL after both techniques, but they found no statistically significant differences in ECL after phacoemulsification versus ECCE. Ravalico *et al.*[9] reported no significant difference in ECL after ECCE (10.1%) versus after phacoemulsification (8.5%). These results are similar to that reported in the present study, which documented no significant difference in ECL after both techniques 1 month postoperatively (10.9% after phacoemulsification vs. 11.7% after ECCE).

Another study by Bourne *et al.*[10] compared phacoemulsification with conventional ECCE and their effect on corneal ECL. No significant difference in overall corneal ECL was found between these two procedures (14.1% in ECCE group vs. 16.2% in phacoemulsification group).

Stumpf and Nose[11] reported in their study the same results of no significant difference in ECL after both techniques (28.5% in ECCE group vs. 34.7% in phacoemulsification group). The higher percent of ECL in their study could be explained by longer follow-up period of 6 months and the use of phacoemulsification in cases with very hard cataract (grades V and VI). For this reason, in the present study, phacoemulsification was not used for management of very hard cataract (grades V and VI). These cases are considered by many authors to be risky for phacoemulsification and ECCE would be safer [10,11].

In this study, removal of the nucleus was done by stop and chop technique in the phacoemulsification group. However, it was reported that there are no statistically significant differences in the effect of different techniques of phacoemulsification on the corneal endothelium. Park *et al.*[13] in their study reported no difference in ECL after both stop-and-chop technique and the phaco-chop technique. When comparing the phaco-chop technique versus the divide-and-conquer technique, a 3-month follow-up study did not reveal any statistically significant difference in the ECL after cataract surgery using the either technique [14].

None of the patients included in this study lost endothelial cells beyond the critical cell density that

can lead to corneal decompensation. This is owing to restricted exclusion of patients susceptible to severe endothelial damage. The occurrence of posterior capsular tear and vitreous loss leads to higher ECL (18.9 vs. 11.5%, $P = 0.003$), as reported by Bourne *et al*. [10]. As we excluded any complicated surgery, this factor did not play a role in the present study.

In our study, CV significantly increased and percentage of normal HEX significantly decreased 1 month after both techniques. This was also reported in the study by Ravalico *et al*.[9] which reported an increase in CV after phacoemulsification and ECCE with more rapid morphological rearrangement and endothelial function recovery after phacoemulsification than ECCE. It was reported that CV returned to near preoperative value 1 month after phacoemulsification, whereas it is still altered 1 month after ECCE. Bourne *et al*.[10] also found the CV of central cornea and percentage of HEX significantly changed at 1 month postoperatively with returning to near the preoperative levels by the end of the third month postoperatively.

The age of patients is considered as an important factor that affects the ECL after cataract extraction. Bourne *et al*.[10] reported that the ECL ranged from 12.3% in the age group of 40–59 years to 27.5% in the age group of 80–90 years. In the present study, we limited the age of patients between 60 and 70 years old in both groups.

In summary, the proper selection of the cataract surgical technique is essential in reducing endothelial damage. For this reason, the authors in this study used phacoemulsification in the management of senile cataract with nuclear hardness up to grade IV and ECCE in cases with grades of V and VI. No statistically significant difference in the ECL after the two techniques was reported.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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