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Evaluation of early corneal endothelial cell loss in bimanual microincision cataract surgery (MICS) in comparison with standard phacoemulsification

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PURPOSE. *To analyze early corneal endothelial cell loss due to microincision cataract surgery (MICS) in comparison with standard phacoemulsification through the temporal clear corneal incision.*

METHODS. *The examined group consisted of a nonrandomized, consecutive prospective series of 20 eyes of 20 patients who underwent uneventful microincision cataract surgery. Twenty eyes of 20 patients who underwent standard phacoemulsification with foldable intraocular lens (IOL) implantation served as a reference group. Patients with corneal disorders, contact lens wear, previous intraocular surgery, and a history of ocular trauma were excluded from the study. Patients were examined preoperatively and 10 days postoperatively. The following items were evaluated in this study: corneal endothelial cell density, intraoperative phaco power, effective phaco time, as well as pre- and postoperative visual acuity. Corneal endothelial cell counts were done in the central part of the cornea using a non-contact Topcon SP 2000P specular microscope before and 10 days after the surgery. The measurements were performed in a semiautomated, masked manner. Statistical analysis was done using nonparametric tests (Wilcoxon signed-ranks test and Mann-Whitney U test).*

RESULTS. *All patients in the study underwent uneventful surgery. Best-corrected visual acuity (BCVA) examined 10 days postoperatively in the MICS group was 0.94±0.094, whereas in the standard phacoemulsification group it was 0.90±0.094. There was no significant difference between BCVA in the two groups (Mann Whitney U two-tailed test: $p>0.05$). In both groups there was a significant decrease in postoperative endothelial cell densities (ECDs) when compared to preoperative values. Mean postoperative ECDs were 2235±418 cells/mm^2 in the MICS group and 2079±399 cells/mm^2 in the standard phacoemulsification group; the difference was not statistically significant (Mann-Whitney U test: $p>0.05$). Patients in the MICS group lost an average of 9.5% of cells, whereas patients after standard phacoemulsification lost about 7.6% of cells. This difference was statistically insignificant.*

CONCLUSIONS. *Microincision cataract surgery induced corneal endothelial cell loss similar to a standard phacoemulsification and allowed excellent visual results in this series of patients. These results support the use of MICS technique for cataract surgery. (Eur J Ophthalmol 2006; 16: 798-803)*

KEY WORDS. *Corneal endothelium, Endothelial cell count, ECD, Microincision, MICS, Phacoemulsification*

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INTRODUCTION

In recent years there has been rapid development of surgical techniques in cataract surgery, which was connected with the introduction of new surgical tools and new designs of intraocular lenses (IOLs). Recently, the bimanual technique of phacoemulsification performed through a microincision has drawn much interest, as it is perceived as the next step from the standard phaco in the continuing process of minimizing the incision in cataract surgery (1).

The endothelium is a single layer of cells located at the posterior aspect of the cornea (2). Corneal transparency is maintained and controlled by the activity of ionic pumps in the plasma membrane of the corneal endothelium, which is responsible for maintaining the relatively low level of stromal hydration (3).

The corneal endothelial cell monolayer consists of cuboidal cells whose density amounts to about 4000/mm^2 at birth and which slowly and gradually decreases with age to about 1400 to 2500 cells/mm^2 in adults (2, 3).

There is a minimal density of 400 to 500 cells/mm^2 required to maintain the endothelial pumping function (2, 4).

As the number of cells slowly decreases (either with age or as the result of damage caused by trauma, corneal infections, or diseases) the heterogeneity in cell size (termed polymegathism) increases. When the endothelium is injured (and when cells are lost), the defect in the monolayer is repaired through enlargement and spreading of neighboring cells. When the number of endothelial cells is greatly reduced, the ability to maintain or restore normal barrier and pump function can be significantly compromised.

Corneal endothelial disfunction may result in corneal decompensation, which in turn causes corneal edema and decreased visual acuity (2, 3).

The endothelial cell count done pre- and postoperatively can serve as a useful factor estimating the level of corneal damage caused by surgery.

The purpose of the study was to analyze early corneal endothelial cell loss due to microincision cataract surgery (MICS) in comparison with the standard phacoemulsification through the temporal clear corneal incision.

PATIENTS AND METHODS

The examined group (Group I) consisted of a nonrandomized, consecutive, prospective series of 20 eyes of 20 patients who underwent uneventful MICS. Twenty eyes of 20 patients who underwent standard phacoemulsification with foldable IOL implantation served as a reference group (Group II).

All patients had a similar degree of nuclear opacification (NI or NII) and a similar degree of cortical opacification (CII or CIII) according to LOCS II scale. All cataract surgeries in both groups were performed under local, topical (2% lidocaine gel), and intracameral (1% lidocaine solution) anesthesia by two experienced surgeons (A.S. and W.O.) in 2005 using Alcon Legacy phacoemulsification machine. In all cases Celoftal (2% hydroxypropyl methylcellulose, Alcon) was used as a viscoelastic agent and Ringer's solution was used as the infusion fluid. In all cases from both groups the nucleus was divided using stop and chop technique and burst mode of phacoemulsification was used.

Patients with corneal disorders, previous intraocular surgery, and a history of ocular trauma were excluded from the study. None of the patients was a contact lens wearer.

In the MICS group a self-sealing one-plane trapezoid clear corneal incision (1.4 x 1.7 mm) for a sleeveless phaco tip was created at 2 or 10 o'clock position. Continuous curvilinear capsulorrhexis was done with microforceps by Alio under a viscoelastic agent.

Another incision 1.2 mm wide for an irrigating chopper was created and phacoemulsification and aspiration were performed. After widening the first incision to 1.7 mm, a one-piece acrylic foldable Acri Smart® IOL (AcriTec) was implanted with an injector Acri Shooter A2.

In the reference group a 3.0 mm wide clear corneal incision was created temporally. Capsulorrhexis was done under protection of viscoelastic substance. Two side-ports were created with a 20 gauge MVR blade in the clear cornea for aspiration and irrigation tips. Subsequently, phacoemulsification and aspiration were performed and a three-piece acrylic foldable AcriSof® (Alcon) lens was implanted through the enlarged (3.75 mm) incision.

Corneal endothelial cell counts were done in the

central part of the cornea using a noncontact Topcon SP 2000P specular microscope before and 10 days after the surgery. The measurements were performed in a semiautomated, masked manner (the automatic cell outlines were reviewed and corrected manually by the examiner). An average of 114.98± 11.90 endothelial cells were analyzed in each measurement.

The following items were evaluated in this study: corneal endothelial cell density (expressed as the number of cells per square millimeter), intraoperative phaco power, total ultrasound time, as well as pre- and postoperative visual acuity.

Statistical analysis was done using nonparametric tests. Changes of pre- and postoperative values in the same group were compared using Wilcoxon signed-ranks test and statistical significance between two groups was determined using Mann-Whitney *U* test. All calculations were performed for the significance level α=0.05 using Microsoft Excel software.

All patients in the study underwent uneventful surgery. Patients were examined preoperatively and 10 days postoperatively. The whole study consisted of 40 patients (32 women, 8 men) aged 44 to 86 years (mean age 69.99±11.25). Group I consisted of 20 patients aged 44 to 80 years (mean age 67.6±9.44); Group II consisted of 20 patients aged 45 to 86 years (mean age 72.15±12.64).

RESULTS

Table I shows surgical parameters in both groups. There were no statistically significant differences in either total ultrasound time or phaco power between the two groups.

In the whole examined group the mean preoperative best- corrected visual acuity (BCVA) amounted to 0.28±0.2 and 10 days postoperatively it was 0.92±0.095. A comparison between preoperative BCVA in the two groups revealed no statistical significance (Mann-Whitney *U* test: U=207, Z observed value=0.191, Z critical value=1.960, p>0.05). BCVA examined 10 days postoperatively in the MICS group was 0.94±0.094, whereas in the standard phacoemulsification group it was 0.90±0.094. A comparison between postoperative visual acuity also did not reveal significant difference in BCVA between the two groups (Mann-Whitney *U* two-tailed test: U=263, Z observed value=1.823, Z critical value=1.960, p>0.05), so the visual results achieved by either technique are similar.

Mean preoperative endothelial cell density (ECD) was 2498±401 cells/mm^2 in the MICS group and 2257±428 cells/mm^2 in the standard phaco group. We did not observe a significant difference in preoperative endothelial cell density values between the two groups (Mann-Whitney *U* test: U=256.5, Z observed value=1.528, Z critical value=1.960, p>0.05).

In both groups there was a significant decrease in postoperative ECDs when compared to preoperative values (Group I, Wilcoxon signed-ranks test: T=208, Z observed value=3.845, Z critical value=1.960, p<0.001; Group II, Wilcoxon signed-ranks test: T=210, Z observed value=3.920, Z critical value=1.960, p<0.001).

Mean postoperative ECDs were 2235±418 cells/mm^2 in the MICS group and 2079±399

TABLE I - SURGICAL PARAMETERS

	Group 1 (MICS)	Group 2 (Standard Phaco)	U Mann-Whitney test =0.05
Measured values:			
Mean total ultrasound time (s)	53.15 ± 24.72	65.80 ± 24.10	p>0.05
Phaco power (%)	49.75 ± 13.71	44.15 ± 14.37	p>0.05
Settings:			
Aspiration flow (cm^3/min)	25	25	–
Vacuum (mmHg)	400	400	–

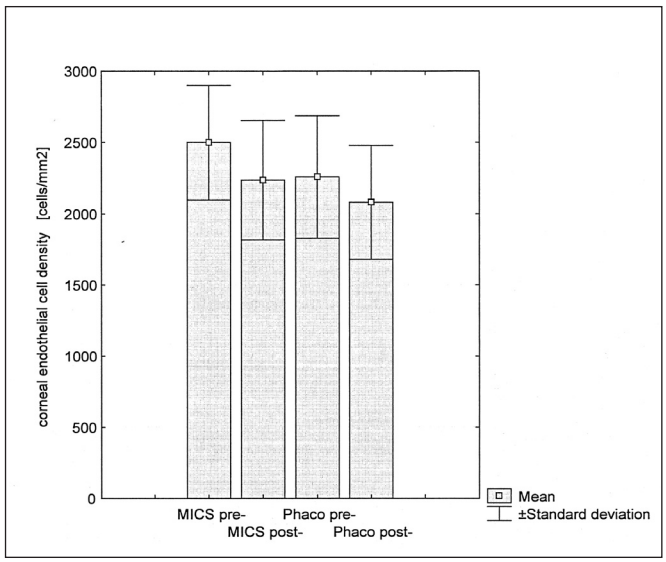

Fig. 1 - *Pre- and postoperative corneal cell density in both groups.*

cells/mm^2 in the standard phacoemulsification group (Tab. II, Fig. 1).

When the corneal endothelial cell loss was expressed as a percentage of preoperative endothelial cell count we found that patients in the MICS group lost an average of 9.5% of cells, whereas patients after standard phacoemulsification lost an average of 7.6% of cells.

Nevertheless, we found that this difference was not statistically significant (Mann-Whitney *U* two-tailed test: U=222, Z observed value=0.595, Z critical value=1.960, p>0.05). Moreover, we observed a postoperative increase in average cell size and a postoperative decrease in endothelial cell hexagonality in both groups (Tab. II).

DISCUSSION

The evolution of surgical techniques of cataract surgery in the last decades was connected with a constant tendency to decrease the width of incision. In view of this, MICS technique (defined by Alio et al as phacoemulsification performed through an incision smaller than 2 mm) combined with implantation of the latest generation IOL seems to be the major step towards minimizing the incision in cataract surgery (5, 6). High stability of the incision, quick wound healing, rapid visual rehabilitation of patients, minimal or absent surgically induced astigmatism, easy IOL implantation with an injector, and decreased risk of intraocular infection are suggested advantages of this method (1, 5, 6).

Corneal endothelial cell count is an important indicator of corneal health. Specular microscopy has become a standard method of endothelial cell analysis, which is used worldwide.

It is generally held that during uncomplicated cataract surgery endothelial cell loss may be caused by intraoperative mechanical damage (ultrasound vibration, air bubbles, turbulent flow of irrigating solution, floating fragments of cortical masses). Long phaco time, high phaco power, and high total irrigation volume are also known as factors that increase endothelial cell loss (7-10). On the other hand, there were reports stating that continuous anterior chamber infusion minimizes the risk of anterior chamber collapse during the intervention and does not increase postoperative corneal damage (11). Transient postoperative intraocular pressure rise con-

TABLE II - CORNEAL ENDOTHELIAL CELL PARAMETERS

	All (n=40)		Group I (MICS) (n=20)		Group II (Phaco) (n=20)	
	Pre-operative	**Post-operative**	**Pre-operative**	**Post-operative**	**Pre-operative**	**Post-operative**
Average cell size (μm^2)	436.43 ±103.22	498.33 ±199.09	411.50 ±80.43	463.7 ±100.030	461.35 ±103.22	532.95 ±199.09
Cell density (cells/mm^2)	**2376.48 ±432.37**	**2159.18 ±396.93**	**2498.35 ±401.22**	**2235.65 ±418.84**	**2257.85 ±428.46**	**2079.45 ±399.65**
Hexagonality (%)	59.28 ±8.96	53.90 ±10.50	59.80 ±10.93	54.35 ±10.66	58.75 ±8.96	53.45 ±10.50

nected with viscoelastic agent retention in the anterior chamber may also cause corneal endothelial cell loss. Corneal dystrophies, previous surgeries, and trauma are also thought to be risk factors of excessive cell loss. It is also greater in diabetic subjects and in pseudoexfoliation syndrome (7, 12-14).

Our observations confirm previous reports that MICS technique is safe and it enables excellent visual results (5, 6). It should be remembered that all types of cataract surgery are connected with a certain loss of corneal endothelial cells, however, with the use of modern equipment and surgical techniques this loss is not high (7). The average endothelial cell loss due to phacoemulsification is different in various studies and on average it ranges from 4% to 18% (5, 6, 10, 15-18). Alio et al found that there is no significant difference in endothelial cell loss between MICS technique and coaxial phacoemulsification (6). Our data are in accordance with these observations.

We found that in both groups the postoperative endothelial cell loss was significant. In the MICS group an average endothelial cell loss (9.5%) was slightly higher than in the standard phaco group (7.6%), however, the difference between these groups turned out to be statistically insignificant.

We used the same surgical settings and the same type of viscoelastic in all patients from both groups and we did not observe viscoelastic retention in any patient involved in the study. There was no postoperative intraocular pressure rise in any of the patients. Moreover, we used the same type of irrigating solution in all patients, however, we do not have records of the total volume of irrigating fluid used in these groups. In a recent study, Alio et al found that both mean ultrasound power and phacoemulsification time were significantly lower in MICS than in coaxial phacoemulsification (6). In our study we observed that ultrasound time and phaco power did not differ significantly in the examined groups.

Microincision cataract surgery offers an indisputable advantage of a much smaller incision, which results in lower surgically induced astigmatism than coaxial phacoemulsification, which was described by other authors (6). In addition, in our series of patients we found that the microincision technique induced the corneal endothelial cell loss similar to a standard phacoemulsification and it allowed excellent visual results.

From these facts it can be concluded that MICS technique offers superior refractive properties (better astigmatic control) to standard phacoemulsification and enables preservation of corneal endothelial cells equally well. Therefore, understanding the limits of a small case series, our results support the use of MICS technique for cataract and lens surgery.

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