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Comparison of selected parameters of the anterior segment after bimanual phacoemulsification through 1.4 mm microincision, coaxial phacoemulsification through 1.8 mm microincision and coaxial 2.4 mm small incision cataract surgery

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ABSTRACT

Aim of the study: To evaluate and compare the impact of three phacoemulsification techniques on selected parameters of the anterior segment of the eye.

Material and methods: 90 patients who were planned for phacoemulsification, and who fulfilled the inclusion criteria, were selected for the study. Group I consisted of 30 eyes after bimanual 1.4 mm microincision cataract surgery (B-MICS). Group II consisted of 30 eyes after coaxial 1.8 mm microincision cataract surgery (C-MICS). Group III consisted of 30 eyes after coaxial 2.4 mm small incision cataract surgery (C-SICS). Patients were examined preoperatively and 1, 7, 30, and 90 days postoperatively.

Results: No complications were seen. There was no significant difference in anterior chamber depth (ACD), in white-to-white (WTW) distance and central corneal thickness (CCT) between the groups during the follow-up ($p > 0.05$). One day postoperatively mean CCT increased in all groups, next it decreased and one month after surgery it returned to preoperative values. On the first day, there was a statistically significant increase in temporal corneal thickness (at the main incision) in all groups. Next, it gradually decreased. Three months postoperatively, there was a statistically significant difference in the mean temporal corneal thickness between groups – the highest value was in group I and the lowest in group II. In all groups there was a significant postoperative increase in the iridocorneal angles (ICA) measured temporally and nasally ($p < 0.05$).

Conclusions: There were no significant differences between the groups in mean BCVA, mean ECD, central corneal thickness (CCT), anterior chamber depth, white-to-white (WTW) distance and nasal iridocorneal angle (ICA). Patients in the B-MICS group had significantly greater corneal thickness in the main incision, in comparison to other groups. One month after surgery, there was a significantly greater mean nasal corneal thickness in the B-MICS group in comparison to the C-MICS group. One month and 3 months postoperatively, there was a statistically smaller mean iridocorneal angle width, measured temporally, in the B-MICS group in comparison to groups operated on with coaxial techniques. Both microincision cataract surgery techniques are as safe as standard small incision phacoemulsification.

KEY WORDS: optical coherence tomography, OCT, phacoemulsification, microincision, anterior segment, MICS.

INTRODUCTION

Recent years have brought fast development of both surgical techniques and technology in medicine. Phacoemulsification is regarded as the gold standard worldwide, as it is a safe and effective surgical procedure. Nevertheless, phacoemulsification is being constantly developed, and new variations are introduced to clinical practice.

One of the targets of this development was the reduction of the incision width [1, 2]. Smaller incisions shorten visual rehabilitation, offer faster wound healing, minimize postoperative intraocular inflammatory reaction and surgically induced astigmatism, and minimize the risk of fluid leakage from the clear corneal wound [1-3].

Microincision cataract surgery (MICS) is the term introduced in 2003 by Alio, who defined it as phacoemulsification performed though an incision less than 2 mm wide [3, 4].

To date, two basic MICS techniques have been introduced to ophthalmic surgery, namely bimanual microincision cataract surgery (B-MICS) and coaxial microincision cataract surgery (C-MICS).

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In the B-MICS technique phacoemulsification is performed through a 1.4 mm wide clear corneal incision. A sleeveless phaco tip is used, and irrigation and aspiration are separated – irrigation is delivered through an irrigating chopper. It is postulated that this improves the hydrodynamics in the anterior chamber and enables one to lower the ultrasound energy used [5].

In the C-MICS technique phacoemulsification is performed through a 1.8 mm wide clear corneal incision. A phaco tip with a silicon irrigation sleeve is used in this technique [5].

AIM OF THE STUDY

The purpose of the study was to evaluate and compare the impact of three phacoemulsification techniques (i.e. bimanual 1.4 mm cataract surgery (B-MICS), coaxial 1.8 mm cataract surgery (C-MICS) and coaxial 2.4 mm small incision cataract surgery) on selected parameters of the anterior segment of the eye.

MATERIALS AND METHODS

Ninety patients who were planned to undergo cataract phacoemulsification surgery with implantation of a foldable, acrylic intraocular lens (IOL; Incise MJ14, Bausch & Lomb), who fulfilled the inclusion criteria, were selected for the study.

Patients, who after being explained the details of the study gave informed consent, were randomly assigned to one of 3 groups – two study groups and one control group.

Each group consisted of 30 patients. All surgical procedures were performed in the Department of Ophthalmology, Medical University of Lodz, Poland.

For all study protocols all tenets of the Declaration of Helsinki were followed. The study was approved by the Bioethics Committee of the Medical University of Lodz, Poland (no. RNN/230/13/KE).

Study design

Inclusion criteria for the study were: cataract which was an indication for cataract surgery and absence of any exclusion criteria.

Exclusion criteria included: history of any previous ocular surgery, previous ocular trauma, congenital ocular malformations, amblyopia, corneal disorders, preoperative corneal endothelial cell density below the value of 1500 cells/mm^2, history of uveitis, glaucoma, diabetic retinopathy, retinal and macular disorders, connective tissue diseases, complicated phacoemulsification surgery and presence of any other diseases that could affect the postoperative outcomes.

Surgical technique

In all patients, the following preoperative regimen was used: topical tropicamide 1% (Tropicamidum WZF 1%) and phenylephrine hydrochloride 10% (Neosynephrin-POS 10%).

All operations were performed under topical anaesthesia, which consisted of the following elements: proxymetacaine hydrochloride 0.5% eyedrops (Alcaine), lidocaine gel 2% used topically and solution of 1% lidocaine administered intracamerally.

All operations were performed by one experienced surgeon (WO) with a Stellaris machine (Bausch & Lomb). In all patients the same surgical settings of the machine were used. In all cases the same ophthalmic viscosurgical device (OVD) was used (hydroxypropyl methylcellulose 2.0% in saline solution (EYEFILL H.D., Bausch & Lomb)), as well as the same infusion fluid (balanced salt solution – BSS). In all patients from all groups, continuous curvilinear capsulorhexis was created with microforceps, the "stop-and-chop" technique of nucleus division was used and the "burst" mode of phacoemulsification was applied.

In all cases, a single-piece, foldable IOL (Incise MJ14, Bausch & Lomb) was inserted into the anterior chamber with an injector. In group I a "wound-assisted" technique was used, while in groups II and III the IOL was implanted through the main incision.

The whole examined group consisted of 90 eyes of 90 patients. There were 70 (77.78%) women and 20 men (22.22%), aged from 35 to 87 years (mean 71.46, SD ±8.7 years).

Group I consisted of 30 eyes of 30 patients who underwent **bimanual 1.4 mm microincision cataract surgery (B-MICS)**. In group I there were 23 women (76.67%) and 7 men (23.33%) aged between 53 and 87 years (mean = 73.2, SD ±8.03 years). In group 1 a self-sealing 1.4 mm clear corneal incision was created supratemporally with a 1.4 mm wide knife (SLU-14AGF, Kai Medical). A side port (paracentesis) was created with an MVR 20G knife, located 120° from the main incision. After continuous curvilinear capsulorhexis was created, hydrodissection was done. Next, phacoemulsification was performed with a sleeveless phaco tip and an irrigating chopper (MVS1093 20, Braga-Mele 20 Gauge Side Out Chopper, Bausch & Lomb). Cortex removal was performed with aspiration/irrigation through the same incisions. A one-piece intraocular lens was then implanted in-the-bag through the main 1.4 mm incision with an injector in a wound-assisted manner.

Group II consisted of 30 eyes of 30 patients who underwent **coaxial 1.8 mm microincision cataract surgery (C-MICS)**. In group II there were 24 women (80.00%) and 6 men (20.00%) aged between 35 and 83 years (mean = 71.5, SD ±10.52 years). In group 2 a self-sealing 1.8 mm clear corneal incision was created temporally with a trapezoidal 1.6-1.8 mm knife (E7600, Bausch & Lomb). Two side ports (paracenteses) were created with an MVR 20G knife; they were located 90° from the main incision. After continuous curvilinear capsulorhexis was created, hydrodissection was done. Next, phacoemulsification and irrigation-aspiration were performed. A one-piece intraocular lens was then implanted in-the-bag through the main 1.8 mm incision with an injector.

Group III consisted of 30 eyes of 30 patients who underwent **coaxial 2.4 mm small incision cataract surgery (C-SICS)**. In group III there were 23 women (76.67%) and 7 men (23.33%) aged between 57 and 87 years (mean 69.67, SD ±7.29 years). In group 3 a self-sealing 2.4 mm clear corneal incision was created temporally with a 2.4 mm knife (MSL 24, Mani). Two side ports (paracenteses) were created with an MVR 20G knife, 90° from the main incision. After continuous curvilinear capsulorhexis was created, hydrodissection was done. Next, phacoemulsification and irrigation-aspiration were performed. A one-piece intraocular lens was implanted in-the-bag through the main 2.4 mm incision with an injector.

In all patients, at the end of the surgery, saline solution (0.9% NaCl) was used for the stromal hydration of the corneal wound.

Postoperatively, topical antibiotic and steroid eyedrops containing tobramycin 3 mg/ml and dexamethasone 1 mg/ml were applied 4 times daily for 3 weeks, and then 2 times daily for 1 week.

Patient assessments

In all patients preoperative biometry was performed using the IOL Master optical biometry (version 5.4). The IOL calculation formulas were in accordance with the Royal College of Ophthalmologists guidelines 2004: for eyes with axial length below 22.0 mm the Hoffer Q formula was used, while for axial lengths equal to or greater than 22.0 mm the SRK/T formula was applied.

Patients were examined preoperatively and 1, 7, 30, and 90 days postoperatively. All examinations and measurements were performed by one doctor (MKP).

The routine examination at each visit consisted of: evaluation of the best corrected visual acuity using the Snellen charts, autorefractometry with an autorefractometer Tomey (RC-5000), tonometry, and anterior and posterior segment evaluation in a slit lamp.

Cataract severity was graded according to Lens Opacities Classification System III (LOCS III). Patients enrolled in the study had cataract sclerosis grades from II to IV on the LOCS III scale.

Statistical methods

Statistical analyses were performed using nonparametric tests. Pre- and postoperative values in the same group were compared using the Wilcoxon signed-rank test. Statistical significance between unpaired data (independent samples) was determined using the Mann-Whitney U test.

All calculations were performed for the significance level $\alpha = 0.05$. Differences were considered statistically significant at $p < 0.05$.

RESULTS

No intraoperative or postoperative complications were seen in any patient. There were no corneal burns. The surgical parameters of all groups are listed in Table I.

The average ultrasound power used during surgery was the lowest in group I in comparison with groups II and III ($p < 0.05$). However, there was no difference between the groups in absolute and effective phaco time ($p > 0.05$).

Best corrected visual acuity

In the current study, there were no statistically significant between-group differences in mean best corrected visual acuity (BCVA) preoperatively as well as during all the follow-up after surgery (Table II).

The BCVA improved significantly in all groups after surgery ($p < 0.01$). There were no statistically significant differences between the groups in the visual outcomes ($p > 0.05$).

Anterior chamber depth

There was no statistically significant difference in anterior chamber depth (ACD) between the groups during the follow-up ($p > 0.05$). Mean values of anterior chamber depth are shown in Figure 1.

White-to-white distance

There was no statistically significant difference in white-to-white (WTW) distance between the groups during the follow-up ($p > 0.05$). Mean values of anterior white-to-white distance are shown in Figure 2.

Central corneal thickness

There was no statistically significant difference in the central corneal thickness (CCT) between the groups during the follow-up ($p > 0.05$). The mean CCT was 550 μm preop-

Table I. Surgical parameters

Surgical parameters	Group I		Group II		Group III	
	Mean	SD	Mean	SD	Mean	SD
AVE %	9.40	2.61	12.70	2.65	14.30	2.93
APT	32.64	17.98	36.98	51.97	35.67	15.53
EPT	3.33	2.10	3.92	2.53	4.35	2.36
Settings						
Mode	Burst		Burst		Burst	
Aspiration flow (cm^3/min)	25		25		25	
Vacuum (mmHg)	400		400		400	

AVE – average ultrasound power; APT – absolute phaco time; EPT – effective phaco time.

eratively in groups I and II, while in group III it was 540 μm. On the first postoperative day CCT increased in all groups to 580-590 μm. From the 1st to 30th postoperative day CCT was decreasing in all groups. One month after surgery mean CCT returned in all groups to preoperative values – 540-550 μm. There were no statistically significant changes in CCT between the 30th and 90th day after surgery in any of the groups. Moreover, in all groups there was a statistically significant increase in CCT between the preoperative measurement and 1 day after surgery ($p = 0.0001$). In groups I and III CCT measured 7 days postoperatively was significantly thicker than the preoperative value ($p = 0.001$).

Mean values of central corneal thickness are shown in Figure 3.

TableII. Best corrected visual acuity (BCVA)

	Preoperative	1 day postoperative	90 days postoperative
Group I			
Min	0.10	0.30	0.80
Max	0.90	1.00	1.00
Mean	0.52	0.88	0.97
SD	0.19	0.18	0.07
Group II			
Min	0.10	0.50	0.90
Max	0.90	1.00	1.00
Mean	0.47	0.88	0.99
SD	0.19	0.16	0.03
Group III			
Min	0.30	0.40	0.80
Max	0.90	1.00	1.00
Mean	0.56	0.84	0.99
SD	0.18	0.20	0.04

Peripheral temporal corneal thickness

There was no statistically significant difference in peripheral temporal corneal thickness measured preoperatively and 1 day and 1 week postoperatively.

On the first postoperative day, there was a statistically significant increase in temporal corneal thickness measured at the main incision in all groups. During the next follow-up examinations, the temporal corneal thickness gradually decreased.

In the current study, 1 month postoperatively, there was statistically significantly higher mean temporal corneal thickness in group I in comparison to group II ($p = 0.0002$) and group III ($p < 0.0001$). 3 months postoperatively, the mean temporal corneal thickness returned to the baseline in group II, whereas in group I ($p < 0.0001$) and group III ($p = 0.003$) it was statistically higher than the preoperative value.

Moreover, 3 months postoperatively, there was a statistically significant difference in the mean temporal corneal thickness between groups – the highest mean temporal corneal thickness was in group I (B-MICS) and the lowest in group II (C-MICS).

The mean temporal corneal thickness was significantly higher during the follow-up period in group I than the preoperative values ($p < 0.0001$). Moreover, in every group, there were significant differences in postoperative measurements of temporal corneal thickness.

In group II, there was significantly higher mean temporal corneal thickness measured 1 day, 1 week ($p < 0.0001$) and 1 month ($p = 0.001$) postoperatively than preoperative values.

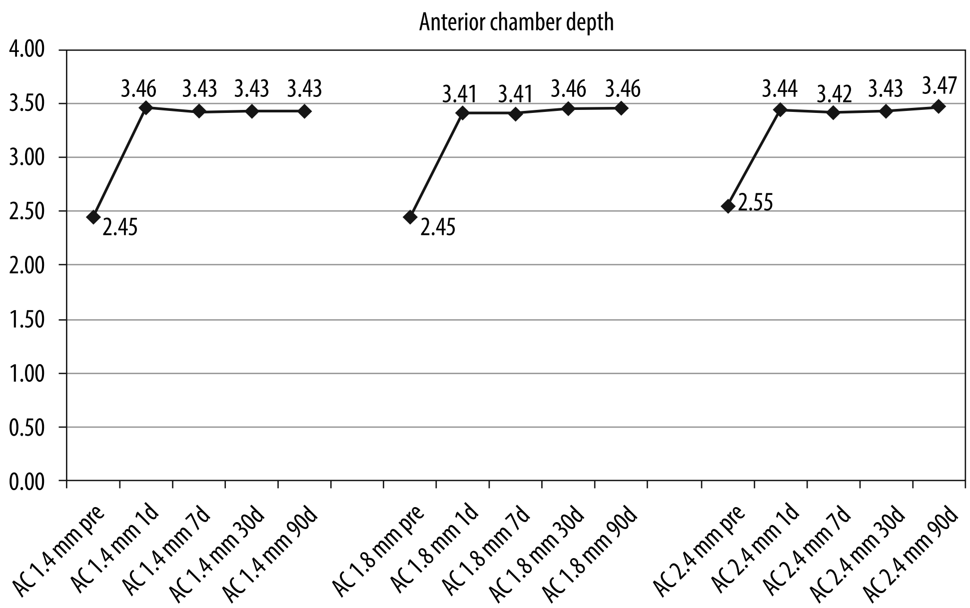

Figure 1. Mean anterior chamber depth (mm) in the examined groups

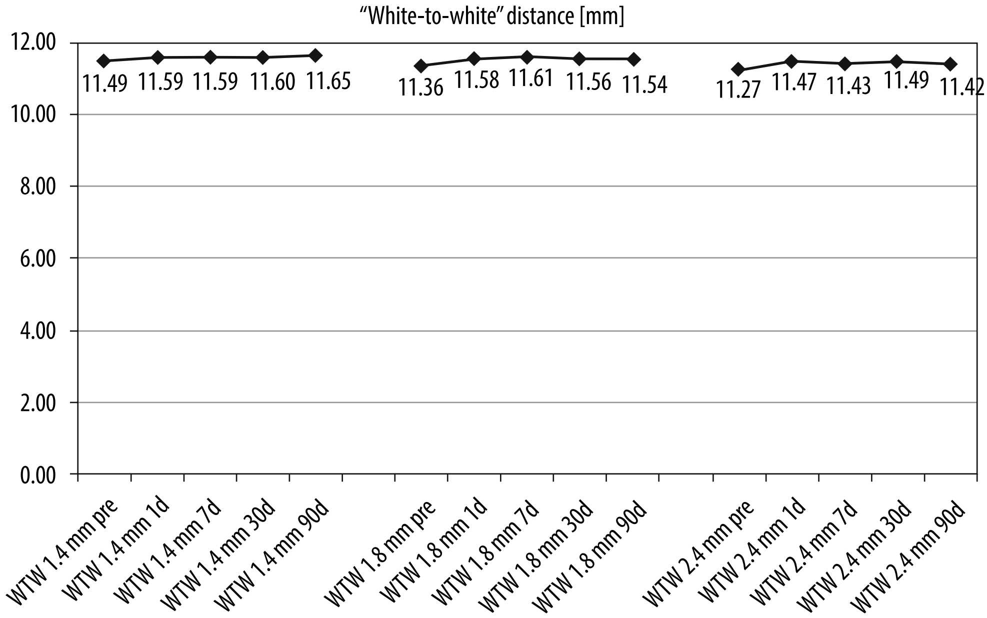

Figure 2. Mean "white-to-white" distance (mm) in the examined groups

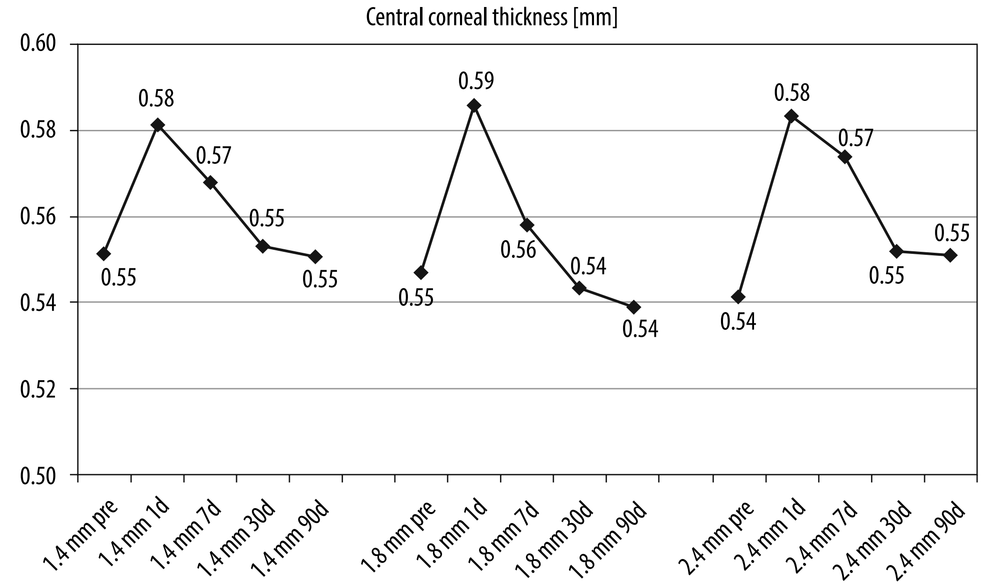

Figure 3. Mean central corneal thickness (mm) in the examined groups

Moreover, in group II, the mean temporal corneal thickness measured 1 day and 7 days postoperatively were significantly higher than measurements taken during the following examinations, performed 1 month and 3 months postoperatively ($p < 0.0001$). In the current study, in group II, a significant decrease in mean temporal corneal thickness values was observed between all postoperative examinations.

In group III, there was a statistically significant difference in temporal thickness between measurements made preoperatively, 1 day, and 1 week after surgery and all further examinations.

Mean values of the peripheral temporal corneal thickness are shown in Figure 4.

Peripheral nasal corneal thickness

There was no statistically significant difference between the groups, in temporal corneal thickness measured 1 month and 3 months postoperatively.

A significant increase in the mean nasal corneal thickness was observed in all groups on the first postoperative day.

In group I (B-MICS), there was statistically significantly higher nasal corneal thickness 1 month postoperatively than in group II (C-MICS) ($p = 0.01$).

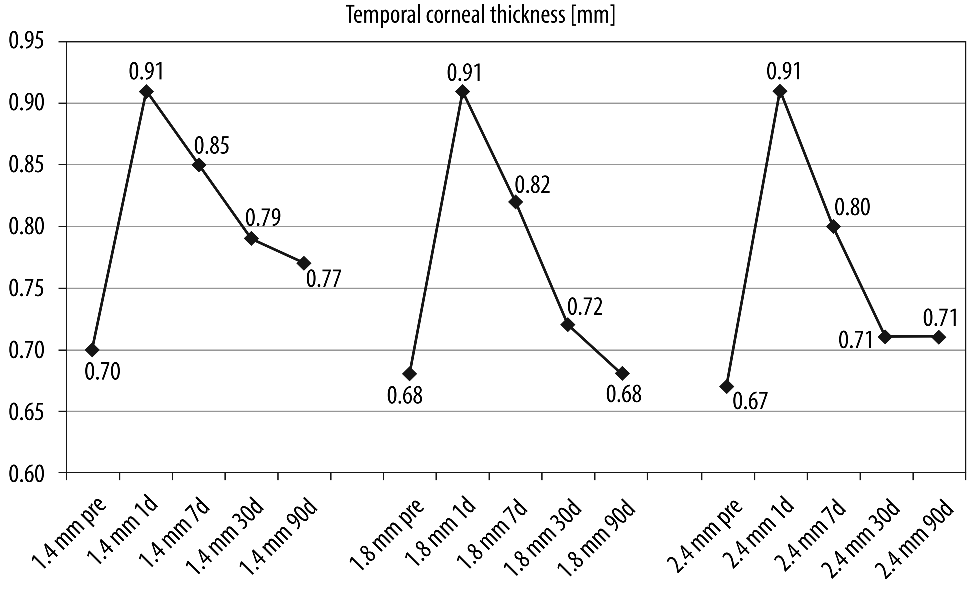

Figure 4. Mean temporal corneal thickness (mm) in the examined groups

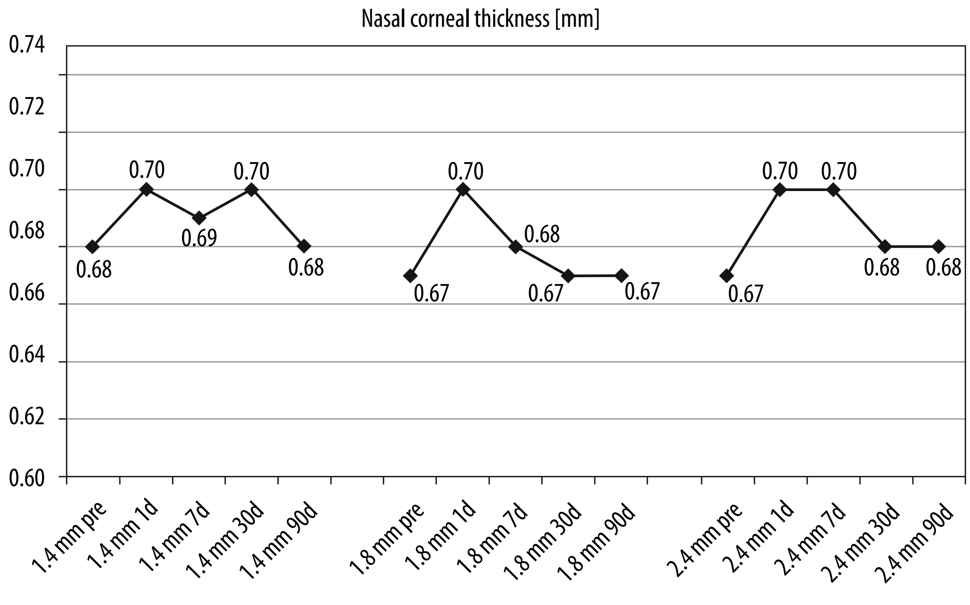

Figure 5. Mean nasal corneal thickness (mm) in the examined groups

In groups I and II, 3 months postoperatively, the mean nasal corneal thickness returned to the preoperative value. In groups III, it was higher than the baseline, but the difference was statistically insignificant.

Moreover, in all groups, there was no statistically significant difference in nasal corneal thickness between measurements performed preoperatively and 3 months postoperatively.

Mean values of the peripheral nasal corneal thickness are shown in Figure 5.

Iridocorneal angles

In the current study, in all groups there was a significant postoperative increase in the iridocorneal angles (ICA) measured temporally and nasally, in comparison to preoperative values ($p < 0.05$). Nevertheless, there were no relevant changes in the mean iridocorneal angle values between the 1st and the 90th day after the surgery.

In addition, there was no statistically significant difference in the mean iridocorneal width, measured temporally, between the groups, preoperatively as well as 1 day after cataract surgery.

In group I (B-MICS), a statistically smaller ICA was found, measured temporally, in comparison to group III during all follow-up visits.

Moreover, the mean temporal ICA measured 1 month ($p = 0.001$) and 3 months ($p = 0.02$) postoperatively was significantly smaller in group I (B-MICS) than group II (C-MICS).

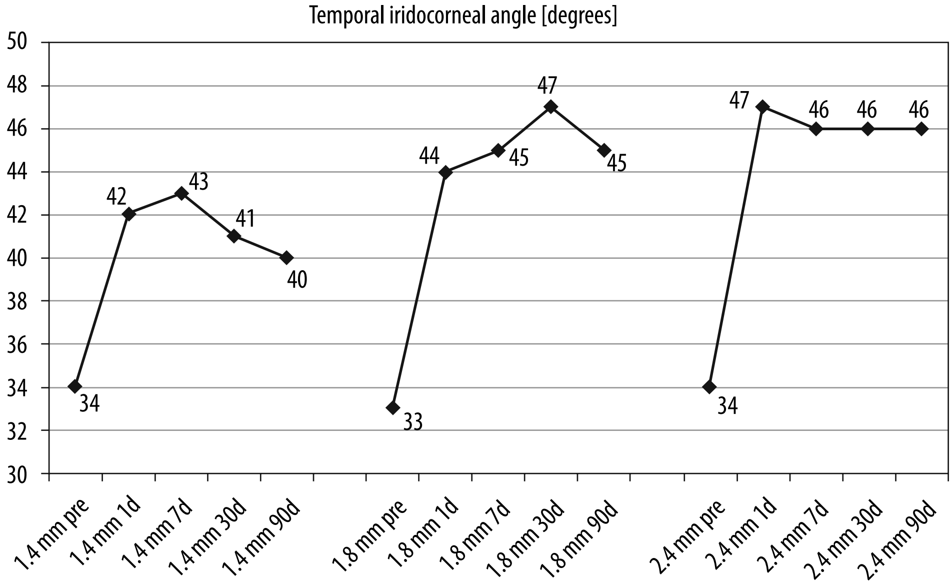

Figure 6. Mean temporal iridocorneal angle [degrees]

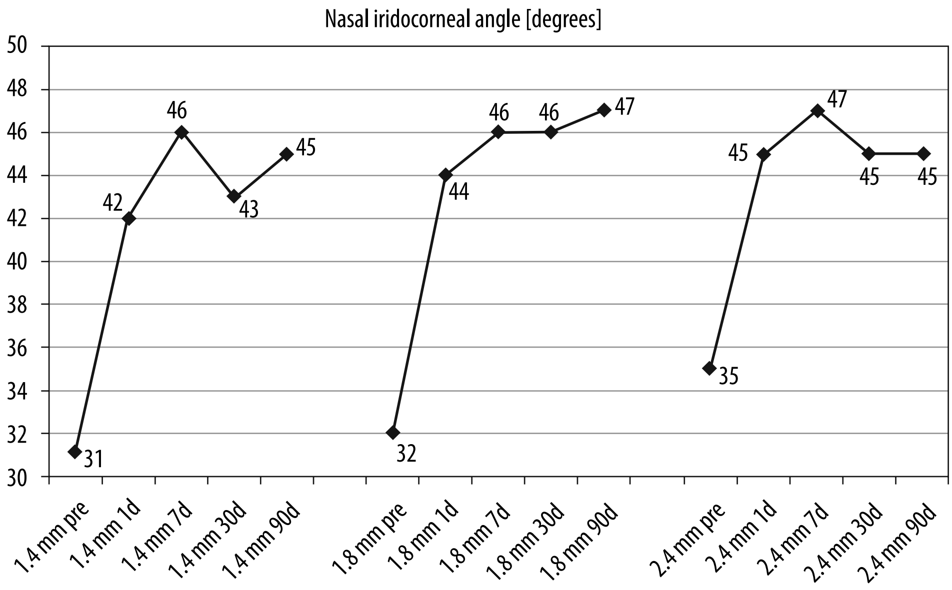

Figure 7. Mean nasal iridocorneal angle [degrees]

Throughout the follow-up, the mean nasal ICA width was larger at every postoperative examination in comparison to preoperative baseline values.

There was no statistically significant difference revealed preoperatively and postoperatively in the nasal ICA width between the groups.

In all groups, the largest nasal ICA was revealed on the 7th day after surgery – in group I it was significantly larger than the value measured 1 month postoperatively ($p = 0.04$), in group III it was significantly larger than the value measured 3 month postoperatively, but in group II the difference was not statistically significant.

DISCUSSION

The evaluation of the anterior segment may provide a lot of useful data, which increase our understanding of the influence of cataract surgery on the anterior segment, anterior chamber fluid dynamics, as well as IOL and corneal wound stability [6].

Anterior chamber depth

In the current study an increased depth of the anterior chamber after phacoemulsification was found, which was confirmed by other studies [6-12]. These studies also confirm anterior chamber depth stability during a 3-month follow-up period.

Gangwani *et al.* [13] did not find significant postoperative differences in the changes of the anterior chamber depth in patients operated on through a small incision and a microincision, during a 2-year follow-up. The results also confirmed no significant changes in the anterior chamber depth and a good IOL stability in both surgical techniques.

Doganay *et al.* [6] measured the mean preoperative depth of the anterior chamber as 2.79 mm. Three months postoperatively, this value increased to a mean of 4.63 mm. In our study the mean ACD was smaller and was 2.45-2.55 mm preoperatively and 3.43-3.47 mm postoperatively.

WTW distance measurements

To date, WTW distance changes after phacoemulsification have not been analyzed. In the current study, no significant changes in WTW distance were found.

Pinero *et al.* [14] measured WTW distance using corneal topography and found that mean WTW was 12.25 ±0.49 mm, which is a greater value than in the current study. Results of WTW in our study (11.42-11.65 mm) are similar to the results obtained by Rufer *et al.* [15], who using corneal topography found it to be 11.71 ±0.42 mm. The differences between various studies may stem from various measuring devices; e.g. Kohnen *et al.* [16] found significant differences in WTW values obtained by Orbscan and IOL Master. Our current results are in accordance with the results published by Wilczynski *et al.* [17] obtained using the same model of AS-OCT.

Central corneal thickness

Evaluation of central corneal thickness (CCT) is a good marker of the influence of the studied surgical technique on the neighboring tissues [18, 19].

Lundberg *et al.* [20] found that the central corneal thickness on the first postoperative day correlates with intraoperative corneal endothelial damage and with the corneal endothelial cell loss, measured 3 months postoperatively.

Denoyer *et al.* [21] found an increase in the central corneal thickness on the first day after phacoemulsification. The CCT 1 day postoperatively measured 535.8 ±20.8 µm. The increase in CCT was significantly larger in the B-MICS group operated through an incision smaller than 2.2 mm than in the coaxial phaco group operated through a 2.75 mm incision.

In the current study the CCT returned to preoperative values after one month postoperatively. Similar results were published by Denoyer [21], as well as Doganay [6].

Kim *et al.* [22] did not find significant differences in CCT between the examined groups: C-MICS (1.8 mm) and C-SICS (2.75 mm). Similar results were obtained in a meta-analysis by Shentu *et al.* [23].

In a meta-analysis by Fu *et al.* [24] no differences in the central corneal thickness were found between B-MICS and C-MICS techniques on the 1st postoperative day, as well as 30 days postoperatively.

In another meta-analysis by Yu *et al.* [25] no differences in CCT between B-MICS and standard phacoemulsification were found during the first 8 weeks after the surgery.

Our study also confirmed no significant difference in mean CCT between bimanual and coaxial technique during a 3-month follow-up. We found that the smallest increase in the central corneal thickness one day postoperatively was in the B-MICS group, which might have been caused by the shorter effective phacoemulsification time in this group [24].

Our results are also consistent with Can *et al.* [18], who also found that 1 day after the surgery the smallest CCT was present in the B-MICS group, although they found the differences to be statistically insignificant.

Peripheral corneal thickness

Etiology of corneal changes after phacoemulsification is multifactorial. Some of these factors are well known, e.g. the localization and width of the corneal wound [26, 27]. Postoperative corneal edema may be caused by turbulent flow of the irrigating fluid and the lens fragments during phacoemulsification or the heat transmission from the phaco tip. Moreover, the fluid used for irrigation during phacoemulsification has a slightly different pH, osmolarity and ionic composition than the aqueous humor, which may cause a stress reaction of corneal cells [28].

Stretching tolerance of the cornea is limited. Excessive stretching of the cornea may result in its damage [29, 30]. This damage can be present in all corneal layers and may influence refractive results and the wound water-tightness.

Many factors can exert an influence on widening and stability of the corneal wound, including the technique of IOL implantation (inserting into the chamber or wound-assisted), the speed of implanting the IOL, as well as the size and shape of the cartridge [31, 32]. Some authors state that making the wound watertight increases the rate of Descemet folds and changes of the corneal wound which remain up to one week postoperatively [33].

In order to standardize the speed of implantation, automatic systems for IOL insertion have been introduced; however, these systems may also cause temporary deformation of the corneal wound [31, 32].

In the current study, it was found that one month postoperatively the temporal corneal thickness within the surgical incision site was significantly higher in the B-MICS group, when compared to the other groups operated on using coaxial techniques.

Moreover, during the follow-up done 3 months postoperatively, significant differences of the corneal thickness between all analyzed groups were found. The highest thickness of the peripheral temporal part of the cornea was found in patients operated on using the B-MICS technique, and the smallest thickness was found in patients operated on using the C-MICS technique. Persistent corneal edema within the surgical incision site found in the B-MICS group may have many causes, e.g.: mechanical trauma caused by wound stretching during the wound-assisted IOL implantation, thermal burn caused by the sleeveless phaco needle, irritation of the corneal wound caused by the turbulent flow of the irrigating fluid, as well as intracorneal injection of BSS to increase watertightness of the wound. Return of the thickness to the preoperative values is a good indication of its healing. It is worth mentioning that in the B-MICS group corneal regeneration was prolonged when compared to the other groups.

The results of measuring the nasal peripheral corneal thickness in groups operated on using a microincision were significantly different only one month postoperatively. In the B-MICS group the nasal peripheral corneal thickness was higher in comparison with the C-MICS group. Three months postoperatively, no significant differences were found.

The temporal peripheral corneal thickness was significantly higher in comparison with the nasal peripheral corneal thickness. It may result from the presence of the surgical wound. The thickening of the temporal peripheral cornea causes in turn a decreased value of the temporal iridocorneal angle.

Kohnen *et al.* [34] found that a wound assisted implantation through an incision smaller than 2 mm causes a smaller extent of corneal stretching than a standard intracameral implantation, which may result from a smaller corneal wound (there is no need for a cartridge). Nevertheless, no IOL manufacturer decided to stop using a cartridge for IOL implantation [35].

In the current study patients operated on using the B-MICS technique through a 1.4 mm incision and wound-assisted implantation, during the follow-up done one month and three months postoperatively, had a significantly thicker peripheral cornea within the incision site.

Denoyer *et al.* [21] analyzed an influence on the cornea of cataract surgery done using the B-MICS technique through a 2.2 mm and 1.7 mm incision (depending on the surgeon's preferences) and a coaxial technique through a 2.75 mm incision (SICS). Preoperative peripheral corneal thickness was 640 ±22 μm. These measurements were about 60 μm smaller than our results. In their study, all patients were operated on using the same phaco machine, which was the same as our equipment (namely Stellaris by Bausch & Lomb). Denoyer *et al.* found that on the first postoperative day there was a significantly larger increase of central corneal thickness as well as peripheral thickness within the incision site in patients operated on using a bimanual technique through an incision smaller than 2.2 mm, in comparison with patients operated on using a coaxial technique through a 2.75 mm incision. In the study by Denoyer *et al.* in both groups, i.e. B-MICS and SICS, the corneal thickness within the incision site returned to preoperative values one month postoperatively, whereas in our study, in the C-MICS group the corneal thickness within the incision site returned to preoperative values 3 months postoperatively and in other groups it was higher in comparison with preoperative values. Faster corneal regeneration in patients examined by Denoyer may have been caused by less advanced cataract. They established an inclusion criterion of grade II and III on the LOCS III scale, whereas in our study patients with cataract grade II to IV were enrolled.

In our study, in the B-MICS group and the 2.4 mm group 30% and 33% of patients, respectively, had cataract grade IV. In the C-MICS group 20% of patients had cataract grade IV, which may explain the faster corneal healing in this group and return of the corneal thickness to preoperative values 3 months postoperatively.

Patients examined by Kim *et al.* [22] had a mean preoperative peripheral corneal thickness ranging from 745.12 μm to 750.37 μm, which is a higher value than in patients examined in our study (670-700 μm). Kim *et al.* found that during the follow-up visit one week postoperatively, peripheral corneal thickness within the incision site was significantly higher in patients operated through an incision 1.8 mm and 2.2 mm wide than in patients operated on through a 2.75 mm incision.

A limitation of our study is the fact that no qualitative analysis of the corneal wound was done (e.g. retraction of the posterior part of the corneal wound, epithelial defects and endothelial defects in the surgical wound), and no intraoperative measurements of the corneal wound were done, which might have helped in showing the extent of corneal wound stretching [36, 37].

Iridocorneal angles

Significant widening of the iridocorneal angles after uncomplicated cataract extraction have been confirmed in many studies [6, 8, 11].

Results of a study by Doganay *et al.* [6] confirm our results. The authors obtained similar values of iridocorneal angles preoperatively, as well as during the 3-month follow-up.

CONCLUSIONS

Based on the study that was conducted and the analysis of the results, the following conclusions have been drawn:

There were no statistically significant differences between the groups in mean BCVA during all follow-up visits. There were no statistically significant differences between the groups in mean endothelial cell density, central corneal thickness (CCT), anterior chamber depth, white-to-white (WTW) distance and iridocorneal angle (ICA) measured nasally, during the whole follow-up period. Patients in the B-MICS group had significantly larger corneal thickness in the main incision, in comparison to the other groups, for 3 months of follow-up. One month after surgery, there was a statistically significantly larger mean nasal corneal thickness in the B-MICS group in comparison to the C-MICS group. However, in all groups, there was no statistically significant difference in mean nasal corneal thickness between measurements performed preoperatively and 3 months postoperatively. One month and 3 months postoperatively, there was a statistically smaller mean iridocorneal angle width, measured temporally, in the B-MICS group in comparison to the other groups, operated on with coaxial techniques. Both microincision cataract surgery techniques (B-MICS and C-MICS) are as safe as standard small incision phacoemulsification.

DISCLOSURE

The authors declare no conflict of interest.

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