(44)

Evaluation of macular thickness after uneventful phacoemulsification in selected patient populations using optical coherence tomography

Ocena grubości siatkówki po niepowikłanej fakoemulsyfikacji zaćmy u pacjentów z wybranych grup za pomocą optycznej koherentnej tomografii

Joanna Gołębiewska, Dariusz Kęcik, Monika Turczyńska, Joanna Moneta-Wielgoś, Dorota Kopacz, Katarzyna Pihowicz-Bakoń

Department of Ophthalmology, Medical University of Warsaw
Head: Professor Dariusz Kęcik, MD, PhD

Abstract:

Purpose: To quantitatively evaluate the effect of uneventful phacoemulsification on central retinal thickness and foveal volume with regard to the following factors: age, gender, systemic diseases: diabetes mellitus, arterial hypertension, coronary heart disease, phacoemulsification parameters (power and time); and to identify patient population at high risk of postoperative changes in macular thickness.

Material and methods: 87 eyes of 87 patients were examined. Foveal volume and central retinal thickness were measured using optical coherence tomography on postoperative days 1, 7, 30, 90 and 180. 10 patients did not complete the study, because of independent factors, these were excluded from the analysis. The results were analyzed within the predefined patient groups.

Results: There was a significant increase of central retinal thickness and foveal volume values on postoperative days 7, 30, 90 and 180, as compared to baseline (1st day after surgery). These values were higher in males and in patients with coronary heart disease. The presence of diabetes and hypertension was associated with the increased central retinal thickness, especially when both considered factors were present. No significant relation was found between the patient age and central retinal thickness during the 6-month's follow up. However, a significant association was observed between the age and the risk of retinal thickening. Higher phaco power (over 40.0%) settings increased both central retinal thickness and the risk of retinal thickening during the follow-up period.

Conclusion: There is a significant increase in macular parameters after uneventful phacoemulsification. Despite downward trend, they remain elevated throughout the 6-month observation period. Diabetes and hypertension increase the risk of postoperative changes in macular thickness, especially if they coexist. Higher phaco power increases the risk of retinal thickening after cataract surgery. Early macular evaluation using the optical coherence tomography identifies patients at high risk of complications, who might benefit from additional anti-inflammatory treatment.

Key words: macular thickness, optical coherence tomography, phacoemulsification.

Abstrakt:

Cel: ocena wpływu niepowikłanej fakoemulsyfikacji zaćmy na centralną grubość siatkówki i objętość dołka w odniesieniu do konkretnych czynników: wieku, płci, chorób ogólnych takich jak cukrzyca, nadciśnienie tętnicze, choroba niedokrwienna serca, parametrów fakoemulsyfikacji (mocy i czasu ultradźwięków), a także wyodrębnienie grup pacjentów szczególnie narażonych na wystąpienie pooperacyjnych zmian w plamce.

Materiał i metody: do badania włączono 87 kolejnych pacjentów (87 oczu) poddanych zabiegowi niepowikłanej fakoemulsyfikacji zaćmy. Z badania wykluczono pacjentów, u których zaćmie towarzyszyły inne schorzenia narządu wzroku, oraz pacjentów, u których wcześniej wykonano operacje wewnątrzgałkowe czy fotokoagulację laserową siatkówki. Grubość siatkówki w plamce i objętość dołka były mierzone za pomocą optycznej koherentnej tomografii w 1., 7., 30., 90. i 180. dniach od operacji zaćmy. Analizę statystyczną przeprowadzono u 77 pacjentów, z przyczyn losowych, niezależnych od badaczy, 10 pacjentów nie dokończyło badania.

Wyniki: wykazano znaczący wzrost wartości centralnej grubości siatkówki i objętości dołka w 7., 30., 90. i 180. dniach od zabiegu chirurgicznego w stosunku do pomiarów z 1. doby od operacji. Wartości te były wyższe u mężczyzn i u tych badanych, którzy chorowali na niedokrwienną chorobę serca. Występowanie cukrzycy i nadciśnienia tętniczego było związane z większymi wartościami centralnej grubość siatkówki, szczególnie kiedy współistniały te choroby. Podwyższona moc ultradźwięków, zwłaszcza powyżej 40,0%, wpływała na wyższe wartości centralnej grubość siatkówki.

Wnioski: po zabiegu niepowikłanej fakoemulsyfikacji zaćmy dochodzi do istotnego pogrubienia siatkówki w plamce, zmiany te utrzymują się w czasie sześciomiesięcznej obserwacji. Szczególnie narażeni na wystąpienie pooperacyjnych zmian w grubości siatkówki w plamce są pacjenci obciążeni jednocześnie cukrzycą i nadciśnieniem tętniczym. U pacjentów, u których zastosowano zwiększoną moc ultradźwięków (ponad 40.0%), wzrasta ryzyko pogrubienia siatkówki po operacji zaćmy. Ocena ryzyka zmian w plamce może być przeprowadzona już w 1. dobie od zabiegu chirurgicznego, to pozwala na ewentualną modyfikację leczenia pooperacyjnego.

Słowa kluczowe: grubość siatkówki, optyczna koherentna tomografia, fakoemulsyfikacja zaćmy.

ISSN 0023-2157 Index 362646

Introduction

Phacoemulsification is currently one of the most frequent procedures in ophthalmic surgery. The advances in surgical techniques and the development of new microsurgery tools, as well as introduction of new generation intraocular lenses, led to the marked reduction of intraoperative and postoperative complications and shorter visual recovery time. Although contemporary uneventful cataract surgery causes minimal intraoperative trauma, it is still associated with some degree of macular thickening and cystoid macular oedema (CMO).

The introduction of new imaging techniques, such as optical coherence tomography (OCT), enabled detailed evaluation of the retina, detection of subclinical changes in its morphology and thickness, and precise macular assessment after phacoemulsifiaction surgery. The aim of this prospective study was to evaluate the effect of uneventful phacoemulsification on central retinal thickness (CRT), foveal volume (FV) and retinal thickening with regard to the following factors: age, gender, systemic diseases, phacoemulsification parameters (power and time), and to identify groups of patients at high risk of postoperative changes in the macula.

Material and methods

87 consecutive patients (56 female, 31 male), at mean age of 69.48 $\pm$ 10.6 years (range 34.0–86.0), who underwent uneventful phacoemulsification and IOL implantation in the Department of Ophthalmology, Medical University of Warsaw between October 2007 and January 2009 were included in this study. 10 patients did not finish the study, they were excluded of analysis.

Exclusion criteria were: intraoperative complications, previous intraocular surgery, history of laser treatment, macular pathologies, uveitis, glaucoma.

The study was approved by the Institutional Review Board at the Medical University of Warsaw. All patients gave their written informed consent upon enrollment.

Patients with diabetes – DM (+) (n = 13), hypertension – HT (+) (n = 41), and coronary heart disease CHD (+) (n = 25) were identified.

Central retinal thickness and foveal volume were evaluated using OCT on days 1, 7, 30, 90 and 180, postoperatively. The same parameters were also measured in 23rd second postoperatively, in healthy fellow eyes of the same patients. All patients were treated with Tobramycin + Dexamethasone for one month after operation.

The study design was prospective and longitudinal. The main endpoints were the changes in central retinal thickness and foveal volume after phacoemulsification surgery. The secondary endpoint was central retinal thickening above 200 μm. The endpoints were analysed with regard to the following factors: age (> 60 years vs. $\leq$ 60 years), gender, diabetes, hypertension, coronary heart disease as well as phacoemulsification parameters.

Cataract surgery was performed by an experienced surgeon using the Infinity platform (Alcon, USA). AcrySof lens was inserted into the capsular bag. Intraoperative parameters: phaco time and phaco power (%) were recorded after each procedure. OCT examination (Stratus OCT, Carl Zeiss Meditec, Inc., San Francisco, CA, USA) was performed through dilated pupil, using the fast macular thickness protocol. The central retinal thickness (μm) (intersection of the six radial scans) and the foveal volume (mm^3) were recorded. Only high quality scans were included into analysis. Statistical analysis included ANOVA (analysis of variance with repeated measurements), logistic regression to estimate odds ratios and generalized additive models to test non-linear relations using GLM procedure, Logistic procedure (SAS System) and the S-PLUS GAM function, respectively. Odds ratios were expressed per 1 SD for each quantitative variable (age, phaco power) and for the appropriate reference level of quantitative variables (e.g. sex, DM, HT etc.). Significance of CRT comparisons during the 6-month's follow up was expressed using the three so-called effects (sufficient to draw conlusions): group, time and interaction between time and group to avoid multiple comparisons error and because of that none detailed comparisons were performed.

Results

During the 6-month's observation period, CRT changed significantly ($p < 0.003$) (Tab. I, Fig. 1). As a result, all measurements taken at 7, 30, 90 and 180 days were significantly higher than baseline values (180.6 $\pm$ 32.0; at day 1).

FV also changed significantly (following a pattern similar to the one of CRT) during the 6-month's observation period ($p < 0.0001$), hence the values at each measurement point (days 7, 30, 90 and 180 postoperatively) were significantly higher as compared to the baseline.

No significant differences were observed between the patient subgroups identified based on factors of interest at baseline (day 1 postoperatively) (see Table I for all significant result levels discussed below).

The mean CRT and FV were significantly higher in males than in females throughout the entire follow up period ($p < 0.0019$) (Tab. I). Patient age was not associated with CRT and FV values. A statistically significant correlation was shown between the central retinal thickness and presence of diabetes. There were no significant differences between the diabetic and non-diabetic patients at baseline, but postoperative CRT increase in diabetic patients was more dynamic ($p < 0.0128$). Although CRT tended to decrease from day 30 onwards in both groups, the mean CRT values were always significantly higher in the DM (+) patients (group effect; $p < 0.0297$). The correlation between the presence of diabetes and changes in foveal volume during the 6-month's observation was less pronounced. Mean FV in DM (+) group tended to be higher as compared to DM (-) group. The differences, however, were not significant (group effect; $p < 0.07$).

A statistically significant correlation was found between hypertension and the increased central retinal thickness (group effect; $p < 0.0379$). Foveal volume changes followed a similar pattern; the values in HT (+) group were higher, but remained at the borderline level of statistical significance.

Furthermore, different combinations of two factors – hypertension and diabetes – were evaluated together to estimate their combined additive effect. The following combinations were considered: DM (+) and HT (+), DM (+) and HT (-), DM (-) and HT (+), DM (-) and HT (-). The differences in CRT between

			Time after surgery/ Czas od zabiegu					Significance levels of ANOVA/ Poziom istotności ANOVA		
			1st day	7th day	30th day	90th day	180th day			
		n	X±SD	X±SD	X±SD	X±SD	X±SD	Group/ Grupa	Time/ Czas	Group* time""/ Grupa* czas""
Total/ Łącznie		77	180.6±32.0	185.5±33.0	189.9±35.5	188.1±35.9	185.4±32.3		0.0030	
Gender/ Płeć	F	51	174.5±30.5	178.2±27.8	181.7±30.1	178.1±26.1	178.5±26.8	0.0019	0.0005	0.2028
	M	26	192.5±32.0	199.9±38.0	206.0±40.1	207.5±44.3	198.8±38.1			
Age/ Wiek	≤60	18	170.1±27.8	171.5±20.5	181.4±20.2	178.6±21.9	178.8±27.3	0.1265	0.0064	0.5109
	> 60	59	183.8±32.7	189.8±35.1	192.5±38.7	190.9±38.9	187.3±33.6			
DM	DM(+)	66	179.2±32.0	183.2±31.0	186.0±31.7	184.0±30.0	181.3±27.8	0.0297	0.0001	0.0128
	DM(-)	11	188.8±31.9	199.1±42.5	213.5±48.0	212.1±56.7	209.6±46.4			
HT	HT(+)	40	174.5±28.6	176.8±23.5	182.5±30.3	181.2±27.3	179.4±24.6	0.0379	0.0024	0.7397
	HT(-)	37	187.2±34.5	195.0±39.1	197.9±39.1	195.5±42.4	191.8±38.3			
CHD	CHD(+)	54	176.9±27.6	180.8±25.0	185.9±29.7	183.1±29.3	182.4±27.0	0.0798	0.0039	0.7075
	CHD(-)	23	189.3±39.9	196.6±45.6	199.3±45.8	199.6±46.7	192.2±42.2			
IPT	<38 s	38	178.9±27.4	182.9±25.9	191.1±29.4	186.2±30.7	188.2±30.9	0.9076	0.0023	0.1271
	≥38 s	39	182.2±36.2	188.1±39.0	188.8±40.9	189.8±40.6	182.6±33.8			
hPP	≤ 40 W	27	174.1±30.9	176.7±24.7	179.4±27.9	180.9±26.1	176.1±23.5	0.0478	0.0013	0.2570
	> 40 W	26	186.7±38.2	198.1±44.5	205.1±47.7	199.2±48.5	192.0±42.5			
DM & HT	D+ H+	7	197.9±30.0	204.6±51.0	219.9±54.6	224.7±63.8	210.6±48.1	0.0416	0.0001	0.0300
	D+ H-	4	173.0±32.6	189.5±24.9	202.3±38.1	190.0±39.2	208.0±50.3			
	D- H+	30	184.7±35.4	192.7±36.5	192.8±33.8	188.7±33.7	187.4±35.2			
	D- H-	36	174.6±28.6	175.3±23.3	180.3±29.2	180.2±26.3	176.2±18.7			
DM & HT	D (+) H (+)	7	197.9±30.0	204.6±51.0	219.9±54.6	224.7±63.8	210.6±48.1	0.0209	0.0005	0.0665
	rest/	70	178.8±31.9	183.6±30.6	186.9±32.0	184.4±30.2	182.8±29.6			

""effect of interaction between time and group/ efekt interakcji między czasem a grupą

Tab. I. Mean CRT values during the follow-up period (F – female, M – male, DM – diabetes mellitus, HT – hypertension, CHD – coronary heart disease, IPT – long phaco time, hPP – high phaco power).

Tab. I. Średnie wartości CRT w czasie obserwacji (F – kobiety, M – mężczyźni, DM – cukrzyca, HT – nadciśnienie tętnicze, CHD – choroba niedokrwienna serca, IPT – długi czas fako, hPP – wysoka moc ultradźwięków).

the groups were observed during follow-up ($p < 0.0416$; group effect). It was noted that the groups differed significantly in the dynamics of increase followed by the subsequent decrease of the mean CRT values – the initial differences between the groups grew significantly in time ($p < 0.0300$; interaction effect). FV values followed a similar pattern to the one of CRT, but the results were not statistically significanct.

As a result of the above comparisons, the DM (+) HT (+) patients were ultimately compared to the remaining patient subgroup. The differences in CRT between the patients with both diagnoses and the individuals unaffected by these systemic diseases were statistically significant ($p<0,0209$) (Tab. I, Fig. 2). They were, however, not significant for FV.

The presence of coronary heart disease correlated with a slight increase of both retinal thickness and foveal volume, espe-

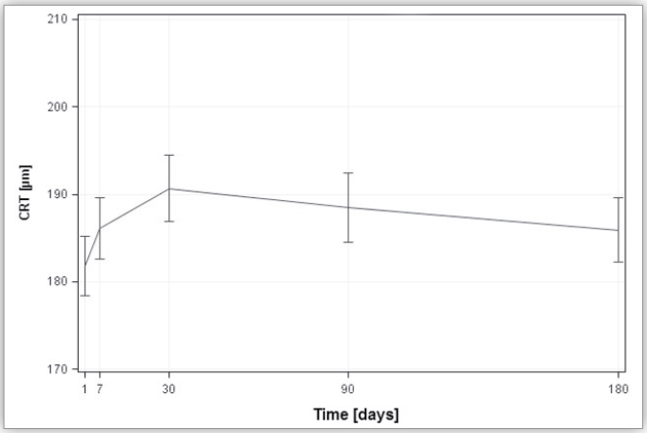

Fig. 1. CRT changes in all patients.

Ryc. 1. Zmiany wartości CRT u wszystkich pacjentów.

ISSN 0023-2157 Index 362646

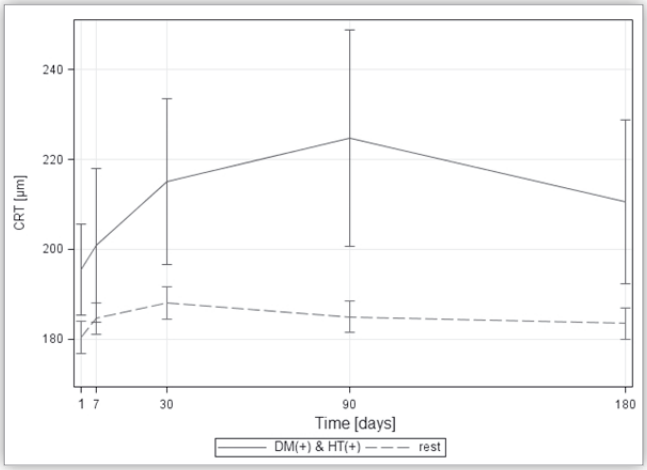

Fig. 2. CRT values in DM (+) HT (+) patients, as compared to other study subjects (DM – diabetes mellitus, HT – hypertension).
Ryc. 2. Wartości CRT u pacjentów DM (+) HT (+) w porównaniu do wartości u pacjentów z pozostałej cześci grupy.

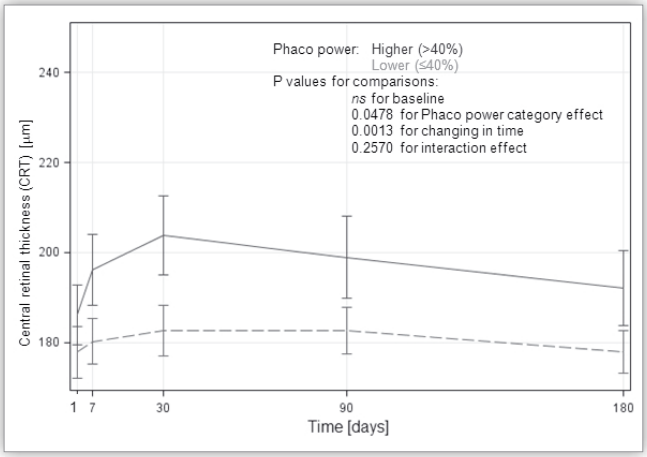

Fig. 3. CRT values in patients with higher and lower applied ultrasound power.
Ryc. 3. Wartości CRT u pacjentów, u których moce ultradźwięków były wyższe i niższe.

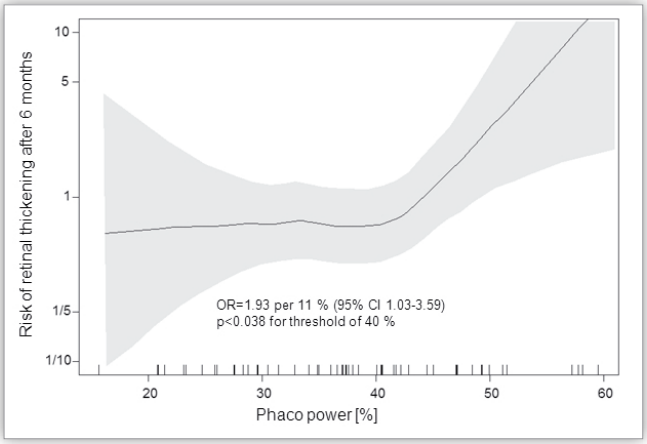

Fig. 4. Risk of retinal thickening according to ultrasound power.
Ryc. 4. Ryzyko pogrubienia siatkówki w odniesieniu do mocy ultradźwięków.

cially at 90 days postoperatively (relative significance levels in CHD (+) and CHD (-) groups compared for CRT an FV were 0.08 and 0.07 respectively).

Phacoemulsification parameter analysis

The median of applied ultrasound – phaco time (PT) and the average phaco power (PP) were analysed. The following subgroups were compared: group with shorter phaco time (≤ 33 s) vs. group with longer phaco time (> 33 s; lPT group) as well as group with lower phaco power (≤ 40.0%) vs. group with higher phaco power (> 40.0%; hPP group). It was observed that the longer phaco time did not have any significant effect on CRT and FV. Although phaco power did not correlate with baseline CRT and FV (on day 1 postoperatively, the significance levels were 0.19 and 0.16, respectively), it was showed some degree of correlation with the mean CRT and FV values during the follow-up. The results were significantly higher in the hPP group. Significance levels for group effect for CRT and FV were $p < 0.0478$ (Tab. I, Fig. 3) and $p < 0.06$, respectively. CRT and FV in 23 non-treated eyes did not change significantly during 180 days of observation.

Risk factors of retinal thickening (CRT > 200 µm) at six months postoperatively

Four risk predicting factors were determined using the logistic regression analysis. Age, sex, hypertension and phaco power were associated with the increased risk of retinal thickening. The associations expressed as odds ratio were: 1.85 (per 11 years; $p < 0.030$), 3.30 (for men; $p < 0.017$), 2.58 (for HT; $p < 0.049$) and for phaco power (1.93 per 11.0%, $p < 0.038$), respectively. A statistically significant 40.0% phaco power threshold was determined for the risk of retinal thickening (P value for nonlinear trend was 0.038). The *plateau* of the risk curve was observed below this value, but it rose sharply when the applied power exceeded the predefined value (Fig. 4).

The phaco power remained the risk factor of retinal thickening even after adjustments for the following covariates: age, baseline CRT, DM, HT, sex, CHD were made. The P values for the series of dual-factors analyses were: 0.33, 0.022, 0.036, 0.078, 0.041 and 0.038, respectively.

Discussion

The results show macular thickness changes after uneventful phacoemulsification. The lack of preoperative OCT measurements is a limitation of the study. Reliable, reproducible measurements of retinal thickness using OCT require obtaining high quality images, in which the external and internal retinal borders can be identified. This is difficult in most patients with cataract, especially subcapsular cataract, where scans are unreliable. According to some authors, cataract causes artifacts, which also renders the measurements less reliable (1–4). In our study group, the lens opacity prevented detailed baseline macular assessment in the majority of patients. The changes in retinal thickness and volume were analyzed postoperatively – when detailed repeatable measurements were possible. Available data shows that retinal thickening is observed from day 6–7 postoperatively (5–11). Greving and Becker measured retinal thickness in OCT just 30 minutes postoperatively and they found no changes within the macula (12).

In line with the findings of other authors, we observed significant changes in CRT and FV beginning from day 7 postoperatively, with a peak at 1 month (13). Cagini, however, observed macular changes only as late as at 12 weeks postoperatively (14).

Retinal thickening decreased slowly or remained stable for at least 6 months after surgery in most patients, which could imply that cataract surgery still had a large impact on the macula.

Many authors studied the effect of phacoemulsification on macula in patients with diabetes, as this disease predisposes to cystic macular oedema due to potential destruction of the blood-retina barrier. In present study, there was no significant difference in retinal thickness between the healthy and diabetic patients on the first day after surgery. However, it should be noted that only patients without diabetic retinopathy were enrolled. The dynamics of retinal thickening was significantly greater in patients with diabetes. Similarly, Degenering observed higher increase in CRT and FV four weeks after surgery in patients with diabetes, as compared to healthy ones, but the differences were not statistically significant (15). Likewise, Biro, Ching and Kim did not observe significant changes in retinal thickening in patients with diabetes (16–18). Jurecka et al. found that in patients with diabetes with no signs of diabetic retinopathy, a similar reaction of macula after phacoemulsification could be expected as in healthy ones (19). Baker et al. observed that the macular edema develops or increases in severity after cataract surgery in eyes with preoperative macular edema or history of previous diabetic macular edema treatment (20). Ostri et al. also observed that visual acuity outcomes after cataract surgery are negatively correlated with the degree of diabetic retinopathy (21). In our study, patients with both diabetes and hypertension had significantly higher CRT and FV from the beginning, as compared to healthy subjects. No significant changes were observed in the subgroup of patients with hypertension only, just as in the work by Pareja-Esteban (22).

We attempted to determine who would be affected by significant postoperative retinal thickening or even CMO. Logistic regression analysis used in this study shows the apparently higher risk of persistent significant retinal thickening (up to 6 months after surgery) in males and in patients over 60 years of age. There is a clear correlation between the initial CRT and FV and the risk of retinal thickening at 6 months postoperatively. The phaco power is an independent factor to affect the risk of long term retinal thickening. We found unless the phaco exceeded 40.0%, the risk of significant retinal thickening did not show any upward trend even in the long-term observation. In line with results obtained by von Jagow and Biro, there was no correlation between the phaco time and retinal thickening (4, 6). Similarly, Cagini did not observe any correlation between the CRT and phaco time in a group of 62 patients (14). Gharbiya et al. did not found any significant correlation between macular thickness and intraoperative factors (13). Mentes et al. observed lower visual acuity in patients in whom the applied ultrasound energy exceeded 1J, but the results were not statistically significant. However the blood-retina barrier was disrupted more often in these patients, as compared to the group where the applied energy was lower than 1J (23). However, these authors did not evaluate the effect of the phaco power.

Conclusion

There is a significant increase in macular parameters after uneventful phacoemulsification. Despite downward trend, they remain elevated throughout the 6-months observation period. Diabetes and hypertension increase the risk of postoperative changes in macular thickness, especially if they coexist. Higher phaco power results in higher surgical trauma, which significantly increases the risk of retinal thickening after cataract surgery. Early macular OCT evaluation identifies patients at high risk of complications, who might benefit from the additional anti-inflammatory treatment.

Authors have no conflict of interest.

References:

1. Ray R, Stinnett SS, Jaffe G.J: *Evaluation of image artifact produced by optical coherence tomography of retinal pathology*. Am J Ophthalmol. 2005; 139 (1): 18–29.
2. Sadda SR, Wu Z, Walsh AC, Richine L, Dougall J, Cortez R, et al.: *Errors in retinal thickness measurements obtained by optical coherence tomography*. Ophthalmology. 2006; 113 (2): 285–293.
3. van Velthofen ME, van der Linden MH, de Smet MD: *Influence of cataract on optical coherence tomography image quality and retinal thickness*. Br J Ophthalmol. 2006; 90: 1159–1162.
4. von Jagow B, Ohrloff Ch, Kohnen T: *Macular thickness after uneventful cataract surgery determined by optical coherence tomography*. Graefes Arch Clin Exp Ophthalmol. 2007; 245: 1765–1771.
5. Kęcik D, Makowiec-Tabernacka M, Golebiewska J, Moneta-Wielgoś J, Kasprzak J: *Macular thickness and volume after uncomplicated phacoemulsification surgery evaluated by optical coherence tomography. A one-year follow-up*. Neuroendocrinol Lett. 2009; 30(5): 610–614.
6. Biro Z, Balla Z, Kovacs B: *Change of foveal and perifoveal thickness measured by OCT after phacoemulsification and IOL implantation*. Eye. 2008; 22 (1): 8–12.
7. Biro Z, Balla Z: *OCT measurements on the foveal and perifoveal retinal thickness on diabetic patients after phacoemulsification and IOL implantation*. Eye. 2010; 24: 639–647.
8. Jurecka T, Batkova Z, Ventruba J: *Macular edema after uncomplicated cataract surgery.* Cesk Slov Oftalmol. 2007; 63 (4): 262–273.
9. Kim SJ, Bressler NM: *Optical coherence tomography and cataract surgery.* Curr Opin Ophthalmol. 2009; 20 (1): 46-41
10. Lobo CL, Faria PM, Soares MA, Bernandes RC, Cunha-Vaz JG: *Macular alterations after small- incision cataract surgery*. J Cataract Refract Surg. 2004; 30: 752–760.
11. Perente I, Utine CA, Ozturker C, Cakir M, Kaya V, Eren H, et al.: *Evaluation of macular changes after uncomplicated phacoemulsification surgery by optical coherence tomography*. Curr Eye Res. 2007; 32 (30): 241–247.
12. Greving R, Becker H: *Retinal thickness immediately after cataract surgery measured by optical coherence tomography*. Ophthalmic Surg Lasers. 2000; 31(3): 215–217.
13. Gharbiya M, Cruciani F, Cuozzo G, Parisi F, Russo P, Abdolrahimzadeh S, et al.: *Macular thickness changes evaluated with spectral domain optical coherence tomography after uncomplicated phacoemulsification*. Eye. 2013; 27(5): 605–611.
14. Cagini C, Fiore T, Laccheri B, Piccinelli F, Ricci MA, Fruttini D, et al.: *Macular thickness measured by optical coherence tomography in a healthy population before and after uncomplicated cataract phacoemulsification surgery*. Curr Eye Res. 2009; 34 (12): 1036–1041.

 ISSN 0023-2157 Index 362646

15. Degenring FD, Vey S, Kamppeter B, Budde WM, Jonas JB, Sauder G: *Effect of uncomplicated phacoemulsification on the central retina in diabetic and non- diabetic subjects.* Graefes Arch Clin Exp Ophthalmol. 2007; 245: 18–23.
16. Biro Z, Balla Z: *Foveal and perifoveal retinal thickness measured by OCT in diabetic patients after phacoemulsification cataract surgery*. Oftalmologia. 2009; 53: (2): 54–60.
17. Ching HY, Wong AC, Wong CC, Woo DC, Chan CW: *Cystoid macular oedema and changes in retinal thickness after phacoemulsification with optical coherence tomography*. Eye. 2006; 20(3): 297–303.
18. Kim SJ, Equi R, Bressler NM: *Analysis of macular edema after cataract surgery in patients with diabetes using optical coherence tomography.* Ophthalmology. 2007; 114: 881–889.
19. Jurecka T, Batkova Z, Ventruba J, Synek S: *Macular edema after cataract surgery in diabetic patients without retinopathy*. Cesk Slov Oftalmol. 2007; 63 (4): 274–284.
20. Baker CW, Almukhtar T, Bressler NM, Glassman AR, Grover S, Kim SJ, et al.: *Macular edema after cataract surgery in eyes without preoperative central-involved diabetic macular edema*. DRCR JAMA Ophthalmol. 2013; 131(7): 870–879.
21. Ostri C, Lund-Andersen H, Sander B, La Cour M: *Phacoemulsification cataract surgery in a large cohort of diabetes patients: visual acquity outcomes and prognostic factors*. J Cataract Refract Surg 2011; 37(11): 2006–2012.
22. Pareja-Esteban J, Moreno-Arrones JP, Drake-Rodriquez-Casanova P, Gutiérrez-Ortiz C, Teus MA: *Morphological macular changes after cataract surgery: risk factors*. Arch Soc Esp Oftalmol. 2009; 84: 605–610.
23. Mentes J, Erakgun T, Afrashi F, Kerci G: *Incidence of cystoid macular edema after uncomplicated phacoemulsification*. Ophthalmologica. 2003; 217: 408–412.

The study was originally received 03.03.2014 (890622)/
Praca wpłynęła do Redakcji 03.03.2014 r. (890622)
Accepted for publication 02.11.2014/
Zakwalifikowano do druku 02.11.2014 r.

Reprint requests to (Adres do korespondencji):
dr n. med. Joanna Gołębiewska
Klinika Okulistyki Warszawskiego Uniwersytetu Medycznego
ul. Lindleya 4
02-005 Warszawa
e-mail: joanna.golebiewska@wp.pl