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## **SUMMARY**

### **Evaluation of macular thickness after phacoemulsification cataract surgery in patients with and without type 2 diabetes using spectral optical coherence tomography**

#### **INTRODUCTION**

The frequency of clinically symptomatic cystoid macular oedema following uncomplicated cataract surgery performed using state-of-the-art methods is between 0.1% and 2.3% in a population of healthy patients. Clinically significant pseudophakic cystoid macular oedema typically develops between weeks four and twelve after surgery, with the peak frequency occurring at weeks four to six. Postoperative retinal oedema in the macula is a complication that is especially associated with cataract surgery in patients suffering from diabetes, particularly with concomitant diabetic retinopathy. The exact pathogenesis of pseudophakic cystoid macular oedema is not fully known.

#### **OBJECTIVES**

The main objective of this study was a four-month analysis of macular thickness following uncomplicated cataract surgery by phacoemulsification in patients with and without type 2 diabetes using spectral optical coherence tomography. Additionally, in all participants of the study, the correlation between selected parameters and postoperative retinal thickness in the analysed area was evaluated.

#### Specific objectives:

1. The assessment of foveal, parafoveal and perifoveal retinal thickness after phacoemulsification cataract surgery in patients with and without type 2 diabetes.
2. The assessment of correlation between glycated haemoglobin level and retinal thickness in the fovea, parafovea and perifovea after phacoemulsification cataract surgery in patients with and without type 2 diabetes.
3. The assessment of correlation between diabetes duration and retinal thickness in the fovea, parafovea and perifovea after phacoemulsification cataract surgery in patients with type 2 diabetes.

4. To determine whether the colour of the iris affects retinal thickness in the fovea, parafovea and perifovea after phacoemulsification cataract surgery in patients with and without type 2 diabetes.
5. The assessment of the occurrence frequency of retinal oedema in the fovea, parafovea and perifovea after phacoemulsification cataract surgery in patients with and without type 2 diabetes.
6. To determine whether glycated haemoglobin level, diabetes duration, the colour of the iris, and age affect the likelihood of retinal oedema in the fovea, parafovea and perifovea after phacoemulsification cataract surgery in patients with and without type 2 diabetes.

## **MATERIAL AND METHODS**

A prospective study conducted at the Department of Ophthalmology at Collegium Medicum in Bydgoszcz, which is part of the Nicolaus Copernicus University, Torun. The study involved patients with type 2 diabetes and patients without diabetes. All participants were admitted to the Department for cataract surgery. Cataract removal was performed by phacoemulsification. Patients were divided into the following groups:

Group 1: Patients with type 2 diabetes without diabetic retinopathy;

Group 2: Patients with type 2 diabetes and non-proliferative diabetic retinopathy;

Group 3: Patients with type 2 diabetes and proliferative diabetic retinopathy;

Group 4: Patients without diabetes.

In group 1, there were 20 people, 11 of whom were female and 9 were male, aged 58 to 81 (mean  $70.85 \pm 6.19$  years). In group 2, there were 20 people, 14 of whom were female and 6 were male, aged 57 to 83 (mean  $73.30 \pm 6.79$  years). In group 3, there were 20 people, 13 of whom were female and 7 were male, aged 67 to 86 (mean  $76.30 \pm 5.38$  years). The group without diabetes consisted of 30 people, 18 of whom were female and 12 were male, aged 57 to 82 (mean  $70.33 \pm 7.18$  years).

Patients suffering from choroidal and retinal diseases (except for diabetic retinopathy) which could influence the examined macular thickness were excluded from the study. Other exclusion criteria were: previous retinal laser therapy; intravitreal anti-VEGF treatment; using diuretics; previous trauma or surgery of the examined eye; intra-operative complications in the course of cataract removal; as well as non-controlled general diseases.

Each patient was examined six times, according to the following pattern:

Visit 1 – on the day before surgery;

Visit 2 – after one week from surgery;

Visit 3 – after six weeks from surgery;

Visit 4 – after eight weeks from surgery;

Visit 5 – after ten weeks from surgery;

Visit 6 – after four months from surgery.

All examinations consisted of: an assessment of the best-corrected distant visual acuity; measurement using an auto kerato-refractometer; intraocular pressure measurement; anterior segment and fundus assessment; and SD-OCT scan. On the day before cataract removal surgery, glycated haemoglobin levels were determined in all patients. SD-OCT scans were obtained with the use of a NIDEK RS-3000 OCT RetinaScan system. The fovea, parafovea and perifovea were scanned according to the Macula Map protocol (6.0 mm x 6.0 mm [256 x 256]) to obtain a numerical map of retinal thickness at the macula, divided into 9 ETDRS sectors. All of the following were analysed: mean foveal, parafoveal and perifoveal retinal thickness; glycated haemoglobin level; diabetes duration; and the colour of the iris.

## **RESULTS**

### **Measurements of retinal thickness in the fovea, parafovea and perifovea**

#### **1. Within each group**

Mean foveal retinal thickness after four months from cataract removal increased from  $261.95 \pm 21.27 \mu\text{m}$  to  $265.55 \pm 21.26 \mu\text{m}$  within the diabetes and no-retinopathy group; from  $269.15 \pm 21.27 \mu\text{m}$  to  $279.65 \pm 24.92 \mu\text{m}$  within the non-proliferative retinopathy group; from  $280.60 \pm 31.61 \mu\text{m}$  to  $301.75 \pm 33.15 \mu\text{m}$  within the proliferative retinopathy group; and from  $266.67 \pm 26.77 \mu\text{m}$  to  $273.63 \pm 26.10 \mu\text{m}$  within the non-diabetic group. In all groups, except for the diabetes and no-retinopathy group, the increase in retinal thickness in the fovea after four months from cataract surgery was found to be statistically significant.

Mean parafoveal retinal thickness after four months of observation increased from  $319.25 \pm 12.98 \mu\text{m}$  to  $323.39 \pm 12.72 \mu\text{m}$  within the diabetes and no-retinopathy group; from  $332.29 \pm 17.66 \mu\text{m}$  to  $340.56 \pm 19.32 \mu\text{m}$  within the non-proliferative retinopathy group; from  $335.74 \pm 19.69 \mu\text{m}$  to  $353.04 \pm 20.29 \mu\text{m}$  within the proliferative retinopathy group; and from  $323.42 \pm 10.42 \mu\text{m}$  to  $330.13 \pm 11.17 \mu\text{m}$  within the non-diabetic group. In all groups, the increase

of retinal thickness in the parafovea after four months from surgery was statistically significant. Mean perifoveal retinal thickness after four months from cataract surgery increased from  $282.46 \pm 11.49 \mu\text{m}$  to  $284.53 \pm 10.61 \mu\text{m}$  within the diabetes and no-retinopathy group; from  $290.43 \pm 15.44 \mu\text{m}$  to  $294.89 \pm 15.88 \mu\text{m}$  within the non-proliferative retinopathy group; from  $297.74 \pm 17.50 \mu\text{m}$  to  $312.45 \pm 19.46 \mu\text{m}$  within the proliferative retinopathy group; and from  $285.48 \pm 7.27 \mu\text{m}$  to  $290.23 \pm 8.58 \mu\text{m}$  within the non-diabetic group. The postoperative increase of mean retinal thickness in the perifovea proved to be statistically significant in all observed groups, except for the diabetes and no-diabetic retinopathy group.

Within the foveal area, the highest postoperative increase in mean retinal thickness occurred after six weeks in the diabetes and no-retinopathy group, non-proliferative retinopathy group, and non-diabetic group; and after eight weeks in the proliferative retinopathy group. In all groups, the maximum increase in foveal retinal thickness proved to be statistically significant.

Within the parafoveal area, the highest postoperative increase in mean retinal thickness was observed after six weeks from the time when cataract was removed in each group. This increase proved to be statistically significant in all of the groups.

Within the perifoveal area, the highest postoperative increase in mean retinal thickness was observed after six weeks in the non-proliferative retinopathy group as well as the non-diabetic group; and after eight weeks in the proliferative retinopathy group as well as the no-retinopathy group. In all of the groups, the maximum increase in retinal thickness within this region proved to be statistically significant.

## 2. Between groups

Statistically significant differences in foveal retinal thickness after a week from cataract removal surgery were found between the proliferative diabetic retinopathy group and all the other groups. After six and eight weeks of observation, statistically significant differences in retinal thickness in this region were recorded between the non-proliferative retinopathy group and the no-retinopathy group; as well as between the proliferative retinopathy group and all the other groups. After both ten weeks and four months from surgery, a statistically significant difference in foveal retinal thickness was discovered between the proliferative retinopathy group and all the other groups.

Statistically significant difference in parafoveal retinal thickness after a week from surgery was observed between the non-proliferative retinopathy group and the no-retinopathy group; as well as between the proliferative retinopathy group and both the retinopathy group and the non-

diabetic group. After six, eight and ten weeks, and after four months from cataract removal, mean retinal thickness measured in this area was significantly different between the non-proliferative retinopathy group and all of the other groups; as well as between the proliferative retinopathy group and all the other groups.

Statistically significant difference in perifoveal retinal thickness after a week from surgery was observed between the non-proliferative retinopathy group and the no-retinopathy group; as well as between the proliferative retinopathy group and all the other groups. After six weeks from cataract removal there was no significant difference in perifoveal retinal thickness only between the non-proliferative retinopathy group and the non-diabetic group. Between all the other groups the difference in mean perifoveal retinal thickness over this time interval turned out to be statistically significant. After eight and ten weeks, and four months from cataract surgery, mean retinal thickness measured in this area was significantly different between the non-proliferative retinopathy group and the no-retinopathy group; as well as between the proliferative retinopathy group and all the other groups.

#### **The assessment of correlation between glycated haemoglobin level and retinal thickness in the fovea, parafovea and perifovea within the groups**

Within the fovea, a statistically significant negative correlation between mean retinal thickness and glycated haemoglobin level was found in the non-proliferative diabetic retinopathy group. A correlative relationship between the above variables was observed after six, eight and ten weeks, as well as after four months from cataract surgery. In the remaining groups, correlation between glycated haemoglobin level and retinal thickness in the fovea did not prove to be statistically significant.

In the parafovea, a statistically significant positive correlation was found between glycated haemoglobin level and retinal thickness in the diabetes and no-retinopathy group, after six, eight and ten weeks from surgery. A negative correlation between the above variables was observed in the non-diabetic group after four months from cataract surgery, as well as before treatment. In the groups of patients with diabetic retinopathy, no significant correlation between retinal thickness in the parafovea and glycated haemoglobin level was observed.

In the perifovea, no statistically significant correlation between retinal thickness and glycated haemoglobin level was discovered for any of the groups over the four-month observation period.

### **The assessment of correlation between diabetes duration and retinal thickness in the fovea, parafovea and perifovea within the groups**

Within the fovea, a statistically significant negative correlation was revealed between diabetes duration and retinal thickness in the non-proliferative diabetic retinopathy group. A significant correlation was observed prior to surgery, and then after six, eight and ten weeks, as well as four months after surgery. No significant correlative relationship was discovered for the foveal area between the above variables within the remaining groups.

In the parafovea and perifovea, no significant correlation was found between diabetes duration and retinal thickness over the four-month observation in any of the groups.

### **The effect of the colour of the iris on retinal thickness in the fovea, parafovea and perifovea within the groups**

Over the four-month observation, the colour of the iris in the assessed patients was not found to have any significant effect on retinal thickness in the fovea, parafovea or perifovea.

### **The frequency of postoperative retinal oedema in the fovea, parafovea and perifovea within the groups**

In the foveal area, retinal oedema occurred anew in two patients from the proliferative diabetic retinopathy group after six weeks from surgery; and in these patients it was visible postoperatively only at this one visit. After eight weeks from surgery, retinal oedema in the fovea occurred anew in another participant from the proliferative retinopathy group. In this patient, the oedema in the area under assessment remained until the end of the observation period. In the diabetes and no-retinopathy group, non-diabetic group, and the diabetes and non-proliferative retinopathy group, no postoperative retinal oedema was found in the fovea in any of the patients during the course of the four-month observation.

Postoperative measurements of retinal thickness in the parafovea and perifovea did not reveal retinal oedema in any patient of any group.

### **The assessment of selected predictors on the occurrence of postoperative retinal oedema in the fovea, parafovea and perifovea**

A statistically significant effect of diabetes duration on the likelihood of postoperative retinal oedema in the fovea was discovered. This likelihood, expressed as odds ratio, increases with each year of diabetes by approximately 1.3 times.

No statistically significant effect of glycated haemoglobin level, the colour of the iris, or participants' age on the occurrence of postoperative retinal oedema in the fovea was found.

In the parafovea and perifovea, no postoperative retinal oedema occurred at any of the measurement points during the four-month observation in any of the patients.

## **CONCLUSIONS**

1. Mean retinal thickness within the fovea, parafovea and perifovea significantly increased after four months from phacoemulsification cataract surgery in diabetic patients with concomitant retinopathy and in non-diabetic patients. Retinal thickness increase in this area was the highest with concomitant proliferative diabetic retinopathy.
2. Glycated haemoglobin level correlated negatively with postoperative retinal thickness in the fovea between week six and month four after cataract surgery in the non-proliferative diabetic retinopathy group; and correlated positively with postoperative retinal thickness in the parafovea between weeks six and ten after surgery in patients with diabetes and without retinopathy; and correlated negatively with postoperative retinal thickness in the parafovea after four months from cataract removal in patients without diabetes. In the perifovea, no correlation between glycated haemoglobin level and postoperative retinal thickness was discovered for any of the groups.
3. Diabetes duration correlated negatively with postoperative retinal thickness in the fovea between week six and month four after cataract surgery in the non-proliferative diabetic retinopathy group. In the parafovea or perifovea, no correlation was found between diabetes duration and postoperative retinal thickness in patients with diabetes.
4. In the present study, the colour of the iris had no effect on postoperative retinal thickness in the fovea, parafovea or perifovea within the groups of patients with and without type 2 diabetes.
5. A higher incidence of retinal oedema in the fovea was observed in diabetic patients with concomitant proliferative retinopathy.
6. Diabetes duration influenced the likelihood of postoperative retinal oedema in the fovea. This likelihood, expressed as odds ratio, increased with each year of diabetes by 1.3 times. Therefore, the duration of diabetes can be a useful predictor of the occurrence of postoperative foveal oedema.

In the present study, the glycated haemoglobin level, the colour of the iris, and age had no effect on the likelihood of postoperative retinal oedema in the fovea.

**Key words:** macular thickness, phacoemulsification, diabetes type 2, SD-OCT