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Original Article

A Study on Central Macular Thickness Changes in Diabetic Patients Undergoing Phacoemulsification

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Abstract

Aim: This study aims to assess central macular thickness (CMT) using optical coherence tomography (OCT) in diabetic patients before and after phacoemulsification.

Materials and Methods: A prospective study on 90 diabetic patients conducted from February 2018 to February 2019, who were all operated for cataract by phacoemulsification. Complete ophthalmological evaluation was done preoperatively. CMT was measured preoperatively using spectral-domain (SD) OCT. Patients were followed at the 1st post-operative day and at 1, 4, and 6 weeks postoperatively. OCT was done during the 6th week of post-operative period.

Results: The mean central 1 mm subfield macular thickness, preoperatively and 6th week postoperatively was 205.12 ± 24.85 μm and 212.79 ± 28.29 μm, respectively. The difference between pre-operative and 6th week post-operative CSMT was significant in all the three groups (no diabetic retinopathy (DR), mild non-proliferative DR [NPDR], and moderate NPDR) (P = 0.001).

Conclusion: SD-OCT detected statistically significant increase in mean CMT at 6-week postoperatively in diabetic patients undergoing phacoemulsification. Precise surgical technique, in the bag implantation of intraocular lens and good post-operative care, blood sugar control reduces the occurrence of macular edema, resulting in good visual outcome.

Key words: Phacoemulsification, Central Macular Thickness, Diabetes, Post cataract surgery

INTRODUCTION

Cataract is one of the common complications of diabetes mellitus, is a leading cause of blindness.[1] Majority of lens opacities in diabetics are nuclear sclerotic in type and they do progress more rapidly and become symptomatic at a younger age than in non-diabetics. Cataract surgery in diabetics is more problematic than non-diabetics. Macular edema (ME) is one of the most common causes of visual loss after uncomplicated cataract surgery. Diabetes has been associated with an increased incidence of post-operative ME.[2]

Cataract surgery-induced surgical trauma resulting in prostaglandins release and blood-retinal barriers disruption is thought to be the cause of ME.[3] Other causes could be vitreomacular traction and light-induced toxicity.

Phacoemulsification is most widely used cataract surgical technique nowadays. Various factors involved in phacoemulsification can influence the tissue structure of eyeball. The ultrasonic energy and fluidics produce mechanical effect that causes inflammatory reaction.

Optical coherence tomography (OCT) has been shown to be highly reproducible in measuring macular thickness in normal individuals and diabetic patients. It is an objective, non-contact, non-invasive, well-tolerated, and highly reproducible method for quantitative retinal thickness measurements, with good reproducibility and with approximately 10 μm resolution.[4] OCT is a well-established method of analyzing the *in vivo* retinal architecture. Spectral-domain (SD) OCT has replaced the conventional time domain OCT as it provides images of higher axial resolution and reduced motion artifacts.

The present study evaluates the changes in central macular thickness (CMT) preoperatively and postoperatively by SD-OCT in diabetic patients undergoing phacoemulsification.

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MATERIALS AND METHODS

This prospective study was designed to assess the effect of cataract surgery on central retinal thickness in diabetic patients. This study was conducted during the period from February 2018 to February 2019 at a tertiary eye care hospital. A total of 90 eyes were enrolled.

Inclusion Criteria

1. Patients aged >50 years with age-related cataract (senile) with diabetes undergoing cataract surgery (phacoemulsification), where fundoscopy and OCT evaluation of macular thickness are possible
2. No diabetic retinopathy (DR), mild and moderate non-PDR (NPDR) without diabetic maculopathy
3. Patients who are willing to come for regular follow-up.

Exclusion Criteria

1. Central corneal opacities
2. High myopic >5D or axial length more than 26.5 mm
3. Patients with present or past history of uveitis
4. Patients with dense cataract
5. Glaucoma patients
6. Patients with severe NPDR and PDR
7. Patients with diabetic maculopathy, clinically significant ME, and ME of any other pathology
8. Previous history of laser treatment
9. Presence of macular pathologies such as age-related macular degenerative changes involving macula, macular scars, choroidal neovascular membrane, and epiretinal membrane
10. Patients with intraoperative complications (posterior capsule rupture, dropped nucleus, vitreous loss, iris trauma, etc.).

Methodology

All patients selected for cataract surgery based on the above-mentioned criteria are evaluated by taking detailed history. Thorough ocular examination has been done, which include slit-lamp biomicroscopic examination, intraocular pressure by Goldmann applanation tonometer, fundoscopy using 90D, indirect ophthalmoscopy, A-scan biometry noting axial length of eye, and intraocular lens (IOL) power. Macular thickness assessment was done before and after cataract surgery using SD-OCT by a single person. Informed written consent was taken from all patients for inclusion in the study and for cataract surgery. Need for post-operative medical and regular follow-ups explained to each patient.

Study participants were grouped for comparison purposes by grades of DR, that is, no DR, mild NPDR, and moderate NPDR.

Patients were given antibiotic eye drops 1 day before operation day and advised to instill one drop hourly, during daytime. Pre-operative macular thickness measurement was done using SD-OCT. The three-dimensional macula protocol was used for macular thickness measurements.

Surgical technique was phacoemulsification with foldable IOL implantation by a single surgeon. Conventional phacoemulsification using Alcon Laureate machine done through a 3 mm temporal clear corneal incision. At the end of the surgery, a subconjunctival injection of 0.5 ml of gentamycin and 0.5 ml of dexamethasone was given in all cases. Postoperatively, all patients were prescribed a combination of dexamethasone and chloramphenicol eye drops in tapering doses for 8 weeks and cyclopentolate eye drops once a day for 1 week.

Post-operative slit-lamp findings were noted down. Visual acuity, anterior segment, and fundus examination findings recorded in all cases on the 1st post-operative day, 7th day, 28th day, and 6th week. OCT done at the 6th week of post-operative period.

Statistical Analysis

All data were analyzed by a descriptive analysis. Chi-square test was used for age, gender, eye laterality, grading of nuclear sclerosis, type of DR, duration of DR, and associated systemic diseases. ANOVA test was used for comparing effective phacoemulsification time and nuclear sclerosis grading. Paired sample *t*-test was used for measuring pre-operative and post-operative 6th week mean macular thickness in early treatment DR study subfields. General linear model was used for comparing type of DR and mean CSMT central 1mm subfield macular thickness.

$P < 0.05$ was considered to be statistically significant.

All the statistical calculations were done through SPSS for Windows (v16.0).

RESULTS

Demographics

Patients age ranged from 50 to 85 years in the study group. Mean age ± standard deviation (years) of patients was 64.14 ± 8.19 years. Males were 62 (65.9%) and females were 28 (31.1%) [Table 1 and Figure 1]. Majority of the patients were in the diabetic duration between 1 and 10 years (51.6%). Mean duration of diabetes in the study group was 8.71 ± 7.79 years. About 80% of patients had no DR, 15% had mild NPDR, and 5% had moderate NPDR.

Changes in Foveal Thickness (μm) in Post-operative Period

1. Preoperatively, the mean central 1 mm subfield macular thickness (CSMT) in the study group was

205.12 ± 24.85 μm. Postoperatively, the mean central 1 mm subfield macular thickness was 212.79 ± 28.29 μm [Table 2]. The difference was found to be statistically significant ($P = 0.001$)

2. The difference between pre-operative and 6th week post-operative CSMT was significant in all the three groups (No DR, mild NPDR, and moderate NPDR) ($P = 0.001$). The increase in mean CSMT, pre-operative, and 6th week postoperatively was higher in patients with moderate NPDR (26.5 μm) when compared to patients without DR (5.06 μm) and mild NPDR (13.44 μm) [Figure 2].

DISCUSSION

One of the important causes of reduced visual outcome after cataract surgery is ME. The incidence of ME has decreased due to the improvement in the cataract surgery from intracapsular cataract extraction to phacoemulsification combined with microincisional techniques and in the bag placement of IOL. Phacoemulsification is most widely used cataract surgical technique nowadays. Various factors involved in phacoemulsification can influence the tissue structure of eyeball. The ultrasonic energy and fluidics produce mechanical effect that causes inflammatory reaction.

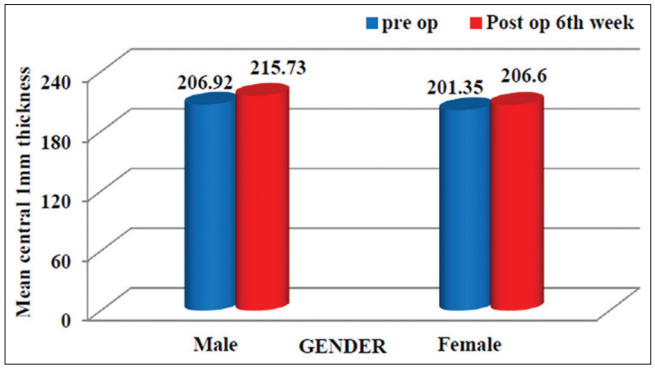

Figure 1: Mean central 1 mm macular subfield thickness in males and females in both groups

Diabetes has been associated with an increased incidence of post-operative ME.[3] The pathogenesis of edema is associated with destruction of blood aqueous retinal barrier by prostaglandins or other inflammatory mediators. Elevated levels of angiogenic factors, inflammatory cytokines, chemokines, and growth factors in aqueous play a role, which leads to increased post-operative inflammation which, in turn, leads to sight-threatening ME, aggravated by cataract surgery.[5]

The study was intended for analyzing the macular changes associated with phacoemulsification in diabetics using OCT. The clinical, demographic, pre-operative, and post-operative data in these patients were analyzed statistically.

In the present study, mean central 1 mm subfield macular thickness (CSMT) preoperatively and 6th week postoperatively was 205.12 ± 24.85 μm and 212.79 ± 28.29 μm, respectively, the difference being significant ($P = 0.001$) [Table 3].

Table 1: Demographics

Sex	Number
Male	62 (65.9%)
Female	28 (31.1%)
Total	90

Table 2: Mean central 1 mm subfield macular thickness between male and female in the study group

GROUPS	MEAN OF PRE OP CSMT (μm)	MEAN OF POST OP CSMT (μm)	*P* value
MALES	206.92 ± 25.32	215.73 ± 29.89	0.300
FEMALES	201.35 ± 24.03	206.60 ± 24.11	
TOTAL	205.12 ± 24.85	212.79 ± 28.29	0.001

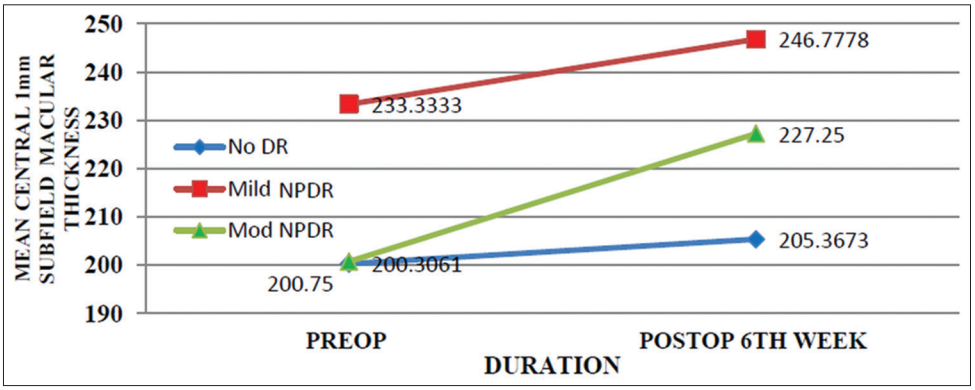

Figure 2: Comparison of pre-operative and post-operative mean central 1 mm subfield macular thickness (CSMT) in no diabetic retinopathy (DR), mild non-proliferative DR (NPDR), and moderate NPDR

Table 3: Comparison of pre-operative and post-operative mean central 1 mm subfield macular thickness (CSMT) in no diabetic retinopathy (DR), mild non0proliferative DR (NPDR), and moderate NPDR

DIABETIC STATUS	MEAN PREOP CSMT (μm)	MEAN POSTOP 6TH WEEK CSMT(μm)	*P* VALUE
NO DR	200.30 ± 19.96	205.36 ± 21.83	0.001
MILD NPDR	233.33 ± 31.77	246.77 ± 30.16	
MODERATE NPDR	200.75 ± 26.39	227.25 ± 39.68	
TOTAL	205.12 ± 24.85	212.79 ± 28.29	0.001

CSMT-- CENTRAL 1mm SUBFIELD MACULAR THICKNESS (CSMT)

In a study done by Katsimpris *et al.*,[6] pre-operative central foveal thickness was 205 ± 18 μm; and post-operative 1 month was 229 ± 21 μm. In a study done by Khedr,[7] CMT measured preoperatively was 201.84 ± 2.02 μm and post-operative CMT was 215.72 ± 3.4 μm.

In a study done by Pukl *et al.*,[8] pre-operative CMT was 238.6 ± 29.0 μm and 1 month postoperatively, CMT was 244.5 ± 24.0 μm.

In the present study, increase in mean CSMT, preoperatively, and 6th week postoperatively was higher in patients with moderate NPDR when compared to patients without DR and mild NPDR. This is similar to the study conducted by Sng *et al.*,[9] in which diabetic patients with moderate NPDR had greater mean CSMT than those with mild NPDR and no DR.

Kwon *et al.*[10] studied 104 subjects (36 men and 68 women). The number of patients without DR was 61 (58.65%), with mild-to-moderate NPDR was 27 (25.96%), and with severe NPDR or PDR was 16 (15.36%). The most common complication was ME, which were occurred in 19 eyes (18.27%) followed by retinopathy progression (11.54%). Among the 19 eyes with ME, 12 eyes (63%) developed ME at 1 month after surgery and 13 eyes (68%) showed improvement of ME by 6 months after surgery. The remaining 6 eyes did not improve by 6 months.

Although post-operative ME is more common in diabetics, it is found to resolve spontaneously in subjects with no or mild NPDR. Clinically significant ME tends to persist or may arise *de novo* or even worsen after cataract surgery in cases with moderate or severe NPDR. A thorough pre-operative evaluation of their retinopathy status is mandatory in these subjects. The need for cataract surgery, their retinopathy status, and the risk of progression should be well discussed with the subjects and their relatives.

We acknowledge some limitations to our study:
1. We did not have control group to compare with
2. Needs longer period of study to see if effects on retinal macular thickness were present or not.

CONCLUSION

- SD-OCT detected statistically significant increase in mean CMT at 6 weeks postoperatively in diabetic patients undergoing phacoemulsification
- The increase in mean macular thickness postoperatively did not affect final visual outcome
- Precise surgical technique, in the bag implantation of IOL and good post-operative care reduces the occurrence of ME, resulting in good visual outcome
- Control of diabetes and treatment of DR before cataract surgery minimizes post-operative retinal macular thickness.

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