

Effectiveness of Cataract Uncomplicated Surgery on Retina Thickness

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^{1,2}Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work, Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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ABSTRACT

Objective: To determine changes in total retinal thickness after cataract uncomplicated surgery.

Methodology: A prospective quasi experimental study was done at the department of Ophthalmology of Combined Military Hospital (CMH), Rawalakot AJK between September and December 2022. Total 28 patients (28 eyes) who underwent phacoemulsification uncomplicated surgery and grafting of intraocular lens in unilateral eye were included. The effective phacoemulsification time and total energy used during phacoemulsification cataract surgery was noted. The optical coherence tomography (OCT) scan was performed to analyze the retina thickness. Data were collected preoperatively, which serves as a baseline measurement. This baseline measurement was used to compare with measurements taken at postoperative day 1, end of week 1, end of month 1, and follow-up period month 3 to assess changes in various parameters such as total retinal thickness.

Results: The patient's mean age comprising of 20 (71.4%) males and 8 (28.6%) females was 54.73 ± 7.6 years. Typically, there is a transient decrease in retinal thickness, immediately after surgery (day 1), followed by a gradual increase in thickness over the weeks (first week) and months (1st & 3rd month) following surgery. Overall, a positive correlation was seen between phacoemulsification time, total energy, and changes in the retinal thickness (1mm & 1-3mm grids) ($p \leq 0.05$).

Conclusion: The study concluded that a follow-up period of at least 3 months is generally recommended after surgery of cataract to assess the whether preoperative levels return of total retina.

Keywords: Cataract; Macular edema; Retina; Surgery; Uncomplicated.

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Introduction

In the worldwide main cause of preventing loss of vision is cataract, and pseudophakic cystoid macular edema (PCME), also called as Irvine-Gass syndrome, is a very known problem after surgery of cataract.¹ PCME is often subclinical and rarely causes vision loss. However, in some cases, unexpectedly it can cause loss of vision and other vision symptoms.² With the use of small incision cataract surgery and phacoemulsification (PE), the prevalence of PCME reduced, which causes less swelling compared to less traumatic and older surgical techniques.³

There is no known pathophysiology of PCME, but it is considered that it is connected to the inflammatory response resulting from cataract surgery.⁴ Cytokines and inflammatory mediators are released in response to surgical trauma, which can cause disruption of blood-retinal barrier and increased vascular permeability, leading to the development of cystoid macular edema.⁵ Several other factors may also increase the risk of PCME. Cataract surgery which become complicated, such as rupture of capsule posteriorly, vitreous loss, lens particles retained, and vitreomacular traction, may increase the incidence of PCME.⁶

PCME typically presents 4-6 weeks after cataract surgery, although it can occur earlier or later.⁷ Fundus fluorescein angiography (FFA) can show a petaloid pattern in patients with dilatation of capillaries, increased leakage from papillary capillaries, and the distribution of fluorescence leakage in a petal-like pattern.⁸ The optical coherence tomography (OCT) imaging method is a noninvasive, which applied light waves to produce a retinal cross-sectional image. OCT is particularly useful for identifying spaces of cysts, retinal thickness, and fluid below retina.⁹ OCT can be used to measure the thickness of different retinal layers in the macula.¹⁰

There is limited data on the effectiveness of post-surgery inflammation on retinal cells and layers. It is our best knowledge there is no any local study to determine the retinal layers by cataract surgery which follow for long time. This study objective was to determine the spectral domain imaging to quantify the thickness of retina before and after cataract surgery, with the aim of gaining other evidence on PCME.

Methodology

A prospective quasi experimental study was carried out in the department of Ophthalmology of Combined Military Hospital (CMH), Rawalakot AJK between September and December 2022. Total 30 patients (30 eyes), who underwent cataract uncomplicated surgeries and posterior intraocular lens implantation were included in the study. Sequel of acquiring study IRB from hospital ethics committee and a written consent from patients to participate voluntarily in this study. However, two patients were later excluded from the study because of follow-up record was missing. As a result, 28 patients (28 eyes) were analyzed in final assessment. Patients with certain conditions or medical histories that could potentially affect the results of the study were excluded from participation. These conditions include vascular occlusion of retina, macular pathology, other eye diseases (such as severe dry eye, uveitis, eye injuries, pseudo-exfoliation syndrome and glaucoma), systemic diseases (including hypertension, diabetes, asthma, or COPD), and inflammatory diseases (such as hepatitis B or C and bowel disease). Patients who were currently using topical and systemic medication or NSAID's were also excluded, as these medications could potentially affect the results of the study. Additionally, patients who experienced intraoperative complications (including posterior capsule rupture, loss of vision, iris prolapse, and low-quality images) were excluded from the study.

Visual acuity was assessed using the Snellen chart, which is a common tool for measuring visual acuity. A detailed biomicroscopic examination of anterior and posterior parts of the eye was performed with pupil dilation. Intraocular pressure was measured using air puff tonometry. The axial length of the eye was measured using Ultrasound Biometer (Nidek, US-4000). All patients had corrected visual acuity of 2/20 or better prior to surgery.

Cataract surgery was performed using the Nidek, CV-9000R. The stop and chop procedure were applied in all surgeries. The effective phaco time and phaco energy measured during surgery. After surgery, patients were given moxifloxacin and dexamethasone topically 4 times a day for 3 weeks and Nevanac 3 times a day for 4 weeks. An experienced ophthalmologist performs all operations and examinations.

OCT Scan Technique: Prior to imaging, all patients underwent pupillary dilation with 1% tropicamide and 2.5% phenylephrine hydrochloride eye drops before scan. In this study, Huvitz, HOCT 1F device was used. The software version 1.3.3 was used, which had a higher repeatability index. The specific parameters used for OCT imaging in this study. The imaging was performed using a 12mm sectional field of view centered on the fovea. 512 A-scan used for B-scan. Images only quality index ≥ 6 were included in this study. After OCT imaging was performed, the inbuilt Huvitz software was used to automatically segment the intraretinal layers in the OCT images. The total retina thickness (TRT) was noted (Figure 1). The thickness of each intraretinal layer was measured for subfield of Early Treatment of Diabetic Retinopathy Study (ETDRS). These subfields were defined as a central 1mm circle and four 1-3mm circles that include superior, inferior, temporal, and nasal regions of retina (Figure 2 A & 2 B). The first preoperative OCT scan is used as reference image in subsequent visits. OCT images are acquired by real-time registration in tracking mode by an ophthalmologist using eye-tracking techniques. If the ETDRS panel is not automatically centered, it is centered manually. Additionally, retinal layer segmentation accuracy was checked in each patient to ensure that data collected were reliable. Data were collected at multiple time points, including preoperatively and on postoperative day 1, end of week 1, end of month 1, and follow-up period. An average thickness of 1mm and 1-3mm grids was measured for further analysis to evaluate the changes in retinal layer thickness following cataract surgery.

The IBM SPSS v 23 software was used for analysis. Descriptive statistics were used to describe the data, with

statistical mean used for measured data and for categorical data percentages were used. The data was examined using the Kolmogorov-Smirnov test. A one-way classification ANOVA was used for comparison of two groups, and p-values corrected by Bonferroni method. Correlation between phacoemulsification time, total energy and retinal thickness variables were measured by Pearson correlation. The level of significance was set at $p \leq 0.05$.

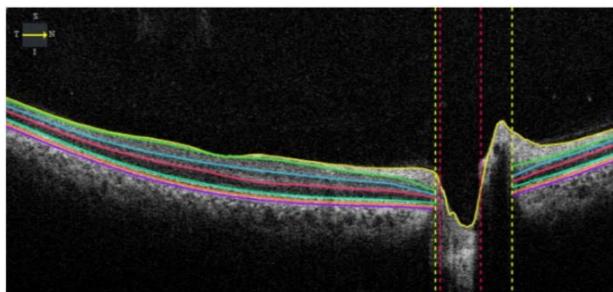


Figure. 1: OCT image of TRT, intraretinal layers boarders.

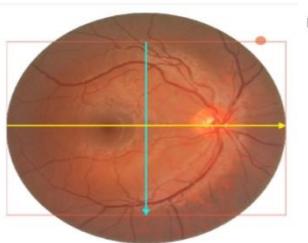


Figure. 2 A

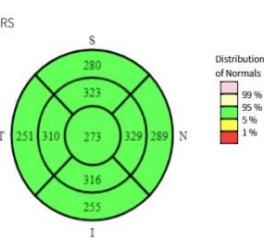


Figure. 2 B

Figure 2A & 2B. OCT image at ETDRS grid of 1mm and 1-3mm circles.

Results

Total 28 patients were enrolled, with majority of males 20 (71.4%), while females 8 (28.6%), and a mean age of 54.73 ± 7.6 years (a range of: 45–70 years). Out of 28 eyes, 22 were right and 6 were left eyes with a preoperative axial length of 22.01 ± 1.1 mm (a range of: 21.1–23.5 mm). The type of cataract was nuclear sclerosis in 13 (46.4%) patients, posterior subcapsular in 9 (32.1%), cortical in 4 (14.3%) patients, and both cortical and posterior subcapsular in 2 (7.2%) patients. The data was normal distributed with insignificant p-values ≥ 0.05 at baseline and follow-up.

We measured total retinal thickness (TRT), in both the 1mm and 1–3mm circle. These measurements were taken preoperatively and during the 3-month follow-up period (Table I).

Effective phacoemulsification time (EPT) mean and mean of total energy (TE) were 77.50 ± 4.23 sec and 5.50 ± 1.14 , respectively. Positive correlation was found ($p \leq 0.05$) between EPT, TE and TRT in both 1mm and 1–3mm circle (Table II & III)

Table I: TRT at the ETDRS both circles of 1mm and 3mm. (n=28)

Total Retinal Thickness (TRT)	1mm circle	3mm circle	P-value
	Mean \pm SD	Mean \pm SD	
At baseline, preoperative	272.64 ± 6.49	320.14 ± 1.72	.0001
At day 1, post-operative	270.25 ± 7.66	315.04 ± 1.93	.0001
At week 1	275.11 ± 4.84	322.29 ± 1.90	.0001
At month 1	277.07 ± 2.75	325.07 ± 1.70	.0001
At month 3, follow-up	278.57 ± 1.93	328.14 ± 1.72	.0001

Table II: EPT effect on TRT. (n=28)

ETDRS grid	1mm circle	3mm circle		
	EPT vs TRT	P-value	EPT vs TRT	P-value
At day 1, post-operative	$r = 1.000$	.0001	$r = 1.000$	.0001
At week 1	$r = .992$	.0001	$r = .986$	.0001
At month 1	$r = .946$	.0001	$r = .962$	.0001
At month 3, follow-up	$r = .926$	.0001	$r = .954$	.0001

Pearson (r) correlation

Table III: TE effect on TRT. (n=28)

ETDRS grid	1mm circle	3mm circle		
	TE vs TRT	P-value	TE vs TRT	P-value
At day 1, post-operative	$r = 1.000$	.0001	$r = 1.000$	.0001
At week 1	$r = .990$	.0001	$r = .985$	.0001
At month 1	$r = .961$	.0001	$r = .964$	.0001
At month 3, follow-up	$r = .930$	.0001	$r = .956$	.0001

Pearson (r) correlation

Discussion

In this study 28 cataract uncomplicated surgeries were performed and analyzed. The basic objective was to determine the total thickness of the retina after cataract uncomplicated surgery. The findings show that a significant difference ($p \leq 0.05$) was found in TRT 1mm and 1–3mm ETDRS circles. The results also showed that there is a positive correlation between EPT, TE and TRT in both 1mm and 1–3mm circle ($p \leq 0.05$). Our results are supported by a study conducted Kurt et al.¹¹ They found that the thickness of the retina and most of the retinal

layers decreased in first post-op day of cataract surgery. But there was an increase in thickness variables, and the values approximately reached the operating level in 1st week. The values of retinal thickness were found higher in 1st and 3rd months, with a significant increase of thickness in all retinal layers in the 1-3mm circle.¹¹

Optical coherence tomography (OCT) imaging method is noninvasive that permits visualization of retinal layers in vivo. However, OCT can also reveal subclinical PCME, which may not be evident on clinical examination alone.⁹ Grewing et al reported a decrease in retinal thickness after cataract surgery that was not statistically significant. The study included ten patients, and retinal thickness was measured before and 0.5 hours after surgery.¹² A decrease in TRT after the first postoperative day following cataract surgery is our observation. The study by Perente et al reported retinal thickness postoperatively non-significant. They suggested a decrease postoperatively day 1 due to pre-cataract light scattering, which may have degraded the quality of imaging.¹³ However, limited evidence is present in the literature to verify this phenomenon.

A study by Sisko et al found the retinal thickness higher in ETDRS foveal area after one month of surgery. However, they observed a slight downward trend in size from 1st to 6th month, without reaching the preoperative level.¹⁴ This finding contrasts with the majority of studies reporting an increase in postoperatively macular thickness.¹⁵ A study by Garbia et al observed significantly increase in postoperatively macular thickness for 6 months.¹⁶ A study by Falcao et al observed an increase in macular central thickness after cataract surgery and concluded that it was a nonpathological measure.¹⁵ The study by Cagini et al at 3 months postoperatively, they found an asymptomatic increase in macular thickness. The study lasted for 7 months.¹⁷ These findings are supported to our study. A study by Gotebiewska et al found an increase in retinal thickness at follow-up up to 6 months after cataract surgery.¹⁸ Similarly, other studies have found increased retinal thickness after cataract surgery.¹⁹

Measuring total retinal thickness may not allow for the detection of alterations in specific retinal structures. One study observed a significant correlation between increased thickness of retina and perioperative higher power of phaco.¹⁸ There are also limited studies that compare the thickness of the postoperatively retinal layer with values of TE and EPT. The use of NSAIDs after cataract surgery has been shown to decrease the magnitude of postoperative macular thickening.²⁰ After cataract surgery, when evaluating the thickness of the retinal layer, avoiding the

use of NSAIDs may be a better option, to better understand the natural postoperative changes.²¹

Our study has several limitations. One limitation is the short follow-up period. A follow-up would provide a more complete understanding of the postoperative changes in retinal thickness. Another limitation is that our study did not evaluate individual retinal layer thickness. Furthermore, our study did not identify any cases of clinical PCME or cystic changes in any of the patients.

Conclusion

The study concluded that a three-month follow-up period was sufficient to observe changes in retinal thickness after uncomplicated cataract surgery. The study found that the greatest retinal thickness was observed in the first and third months after surgery. An increase in thickness after surgery was observed in the 1mm and 1-3mm circles. These findings may have important implications for understanding the pathophysiological pathways of PCME. Long-term studies are needed to answer these questions, as well as to investigate the potential long-term effects of postoperative retinal thickness on visual function and other outcomes.

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