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A Comparative Study of Macular Thickness after Uneventful Phacoemulsification and Small Incision Cataract Surgery Using Spectral Domain Optical Coherence Tomography (OCT) at Tertiary Care Centre in South Gujarat

Nishtha P Patel[1], Priti R Kapadiya[2], Trupti A Bhesaniya[3]

Abstract

Introduction: Cataract contributes to 62.6% overall ocular morbidity and is the main reason of avoidable blindness worldwide. Amongst the complications that follow cataract extraction, CME can occur inspite of utmost care. Optical coherence tomography (OCT) is a non-contact, non-invasive and quantitative imaging modality for assessing macular pathologies like CME. This study assessed the changes in macular thickness after an uneventful SICS and Phacoemulsification surgery. ***Study Design:*** The study was conducted amongst 100 consenting patients who underwent cataract extraction either via SICS or phacoemulsification. They were divided into two groups based on the same. Patients in whom pre-op OCT could be performed, those without any retinal/macular pathology and those had an uneventful cataract surgery were included in the study. Patients with existing macular pathologies, traumatic/pediatric cataract, eventful surgery with intra op use of drugs that could affect the macular thickness were excluded. Patients were examined pre-op and post op at 1 and 3 months. ***Observations and Results***: The changes in mean CMT noted postoperatively at one month and at third month from preoperative mean CMT were statistically significant in both the study groups; however the intergroup difference was not statistically significant. ***Conclusion*:** There is subclinical increase in macular thickness at 1 month postoperative period which resolves by 3 month postoperative period in both the groups (phacoemulsification and SICS) after uneventful cataract surgery. Increase in subclinical macular thickness has no effect on BCVA.

Keywords: SICS; Phaco; OCT; CME**.**

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Introduction

Cataract contributes to 62.6% overall ocular morbidity[1] and is the main reason of avoidable blindness worldwide.[2] Meticulous pre-operative, intra-operative and post-operative care can avoid most of the blinding complications such as cystoid macular edema (CME), secondary glaucomatous optic atrophy, retinal detachment, endopthalmitis, and expulsivehaemorrhage.[3]

Amongst these problems CME may occur inspite of utmost care where the inflammatory process appears to be the main causal factor for the edema. There is a formation of the fluid-filled cystoid spaces between the outer plexiform and inner nuclear layers of the retina, resulting from disruption of the blood-retinal barrier.[4] Even though the specific etiology is not fully understood, major risk factors remain surgical complications such as operative loss of vitreous, posterior capsular rent, previous retinal diseases, diabetes, uveitis and use of the

Author Affiliation: [1]Professor and Head, [2,3]Senior Resident, Department of Ophthalmology, New Civil Hospital, Government Medical College, Majuragate, Surat 395001, Gujarat, India.

Corresponding Author: Nishtha P Patel, Senior Resident, Department of Ophthalmology, New Civil Hospital, Government Medical College, Majuragate, Surat 395001, Gujarat, India.

Email: nishtha.patel29@gmail.com

prostaglandin drops.[5] These triggering agents cause diffusion of prostaglandin and other inflammatory mediators into vitreous cavity which induces a cascade of inflammatory events with subsequent rupture of blood retinal barrier and CME in some patients.[6]

CME can occur as early as 15 days to 9 months.[7] In most instances macular edema is transient and vision recovers rapidly as the process subsides. Subclinical increase in macular thickness is observed postoperatively due to inflammatory insult of the surgery releasing prostaglandins.[8] However, in significant number of patients the morbidity persists for a much longer period. It presents as a significant reduction in visual acuity.

Phacoemulsification is the preferred surgical technique worldwide. Small incision cataract surgery (SICS) is gaining popularity in the developing world where bulk surgeries are performed as it is less expensive, faster and less technology dependent compared to phacoemulsification and has all the advantages of a closed chamber surgery. The main disadvantage of SICS is that it causes more disruption of the blood retinal barrier as compared to phacoemulsification due to large incision size and more iris manipulation.[9,10]

The present study is an attempt to study the changes in macular thickness after an uneventful SICS and Phacoemulsification surgery which will highlight changes in macular thickness according to type of surgery done in relation to various variables.

Aims & Objectives

- To assess macular thickness after uneventful phacoemulsification cataract surgery.
- To assess macular thickness after uneventful SICS cataract surgery.
- To compare macular thickness changes in relation to type of surgery at variable postoperative period.

Materials and Methodology

The comparative prospective study was conducted on 100 patients who underwent uneventful cataract surgery in a tertiary care government hospital in South Gujarat. These patients were examined and investigated thoroughly as per the protocol.Written informed consent for the study was taken prior to enrolment.

All patients who underwent cataract surgery by consultant ophthalmic surgeons performing both SICS and phacoemulsification were taken as study participants.

The patients were divided into two groups as per the surgery performed.

Group 1 Participants operated by phacoemulsification.

Group 2 Participants operated by SICS.

Criteria to put patients under each group depended on the patient's consent for the type of surgery, choice of intraocular lens, affordability when free foldable IOLs were not available in the Government setup and type of cataract.

Inclusion criteria

- Cataract allowing pre-operative OCT to be performed.
- Patients without any retinal or macular pathology.
- Patients who underwent uneventful cataract surgery.

Exclusion criteria

- Patients having any coexisting ocular comorbidities that could affect macular thickness such as ARMD, glaucoma, Diabetic macular edema, Uveitis, Vascular causes (BRVO, CRVO) etc.
- Traumatic cataract, pediatric cataract, eventful cataract surgery, macular scar, macular hole.
- Dense cataract which does not allow OCT.
- Intraoperative use of drugs such as epinephrine, pilocarpine that could affect macular thickness.

Methodology: All patients having cataracts who fulfilled the inclusion criteria were taken in study. Informed written consent was taken from the patient and purpose of the study was explained to the patient after thorough history taken. Patient characteristics such as age, sex, duration of cataract were noted. History of any systemic illness noted. A complete anterior and posterior ocular examination was done for all patients to rule out any other ocular comorbidity.

Pre-operative data collection done as following: Determination of best corrected visual acuity by

illuminated Snellen's chart for 6 meter distance and near vision measured with Roman's near vision chart. Anterior segment examination using slit lamp examination. Dilated anterior segment evaluation for cataract gradation. Dilated Posterior segment examination using direct and indirect ophthalmoscope (Heine), Slit lamp biomicroscopy of the fundus using + 78D lens (Volk). Measurement of intraocular pressure (IOP) by applanation tonometry using Goldmannapplanationtonometre. IOl power calculation using manual keratometry by Bausch and Lomb keratometer and axial length by Appasamy A scan biometry; Baseline macular thickness by spectral domain optical coherence tomography using Topcon's 3D OCT-1 maestro. The 3D macula protocol was used on OCT for macular thickness measurements. It consists of a raster-scan composed of 256×256 (vertical × horizontal) axial scans covering an area of 6×6 mm in the macular region. It reconstructs a false-color topographic image displayed with numeric averages of thickness measurements for each of the 9 map regions within a 6×6 mm area centered on the fovea, as defined by the ETDRS [15]. According to ETDRS map, macula is divided into 9 regions with 3 concentric rings measuring 1 mm (innermost ring), 3 mm (inner ring) and 6 mm in diameter (outer ring) centered on the fovea. The innermost 1 mm ring is the fovea while the 3 mm inner ring and 6 mm outer ring are further divided into four equal regions.Central macular thickness > 250 µm is conidered significant for macular edema.

All patients who participated in the study underwent uneventful cataract surgery by either phacoemulsification or SICS. Balanced salt solution irrigating fluid used in all patients. Patients underwent Phacoemulsification using a 2.8 mm superior or temporal clear corneal incision by stop and chop technique. A foldable intraocular lens was inserted in the capsular bag at the end of surgery. Patients underwent manual small incision cataract surgery using a 6.0 mm superior scleral tunnel incision. A 6.0 mm PMMA single piece rigid intraocular lens was implanted in the bag at the end of surgery.

Post-operative examination at 1 month and 3 months: Determination of best corrected visual acuity by illuminated Snellen's chart for 6 meter distance and near vision measured with Roman's near vision chart. Anterior segment examination using slit lamp examination. Posterior segment examination using direct and indirect ophthalmoscope, 78D. Spectral domain optical coherence tomography.

Statistical Analysis: Data collected and put in excel sheet and were analyzed using SPSS 16.0 software. For the descriptive analysis, the mean, standard deviation, and percentage were used. The t test and Anova test applied for the univariate analysis. A p value <0.05 was considered be statistically significant

Results: In the present study preoperative OCT was done in 100 patients. Out of which 72 patients came for post-operative OCT at one month, later on 8 patients lost for follow up OCT at three months. So for purpose of analysis we have observed 64 patients who underwent uneventful cataract surgery; whose all OCT reports were available. Group 1 includes 31 patients who underwent phacoemulsification and group 2 includes 33 patients who underwent small incision cataract surgery (SICS).

In our study, the mean age of the 31 patients who underwent the phacoemulsification procedure was 57.45 years while the mean age of 33 patients who underwent the SICS procedure was 59.69 years.

In the phacoemulsification group, male (14): female (17) ratio was 1:1.2 while in the SICS group, male (14): females (19) ratio was 1:1.35.

There was variable increase in macular thickness at 1 month postoperative period irrespective of duration of surgery. The difference between increase in macular thickness and duration of surgery was statistically not significant (p value 0.25).

Table 1: Comparison of the preoperative and the postoperative mean central macular thickness (CMT).

Central macular thickness (CMT)	Pre-operative	Post-operative 1 month	Post-operative 3 month	Anova test P value
Minimum	152	157	153	0.0005
Maximum	220	527	232	
Mean	176.07	199.53	177.64	
SD	17.37	59.53	18.73	

There was subclinical increase in CMT at 1 month postoperative period which resolved by 3 month postoperative period, difference being statistically significant (p = 0.0005).

Table 2: Comparison of preoperative and postoperative mean central macular thickness (CMT) according to type of surgery.

Central Macular Thickness (CMT).	Pre-operative	Post-operative 1 month	Post-operative 3 month	P value

Phacoemul-sification	175.87±17.75	201.03±64.1	177.51±20.37	0.02
SICS	176.27±17.29	198.12±55.78	177.75±17.36	0.021

We found increase in subclinical macular thickness at postoperative 1 month and which resolved by 3 month postoperatively which was statistically significant (p value 0.02) in both the groups.

Comparison of CMT at 1 month and 3 month postoperative period between group 1 and group 2 is statistically not significant (t test p value 0.44 and 0.37 respectively).

There were two patients with clinical CME, one in group 1 (phacoemulsification) and other in group 2 (SICS). Clinical CME was observed at post-operative 1 month and resolved by 3 month post-operative after treatment with posterior subtenon injection of triamcinolone.

Table 3: Postoperative BCVA at 1 month and 3 month.

Postoperative BCVA	No of Patients 1 Month (Nos. / Percentage)	No of Patients 3 Month (Nos. / Percentage)
6/36(0.16)	2 (3.1%)	0
6/12 (0.5)	3 (4.68%)	0
6/9 (0.63)	39 (60.9%)	25 (39%)
6/6 (1.0)	20 (31.2%)	39 (60.9%)
Total	64 (100%)	64 (100%)
Mean	0.72±0.21 (decimal) (0.2 LogMAR)	0.85±0.18 (decimal) (0.05 LogMAR)

A statistically significant difference was observed between 1 month and 3 month BCVA (p value 0.0002).

Table 4: Postoperative BCVA according to type of surgery

Post-operative BCVA	No of Patients 1 Month (Nos. /Percentage)		No of Patients 3 Month (Nos. /Percentage)	
	Phaco	SICS	Phaco	SICS
Jun-36	1(1.56%)	1(1.56%)	0	0
06-Dec	1(1.56%)	2(3.12%)	0	0
06-Sep	17(26.57%)	22(34.37%)	10(15.62%)	15(23.43%)
06-Jun	12(18.75%)	8(12.5%)	21(32.81%)	18(28.12%)
Total	31(48.43%)	33(51.56%)	31(48.43%)	33(51.56%)
Mean	0.75(0.1 LogMAR	0.69(0.2 LogMAR)	0.88(0.05 LogMAR)	0.83(0.1 LogMAR)

Comparison of BCVA at 1 month postoperative period between group 1 and group 2 is statistically not significant (p value 0.39). Comparison of BCVA at 3 month postoperative period between group 1 and group 2 is statistically not significant (p value 0.31).

This is because, uncomplicated SICS surgery has comparable visual outcome to phacoemulsification.

Subclinical increase in macular thickness at postoperative 1 month has no effect on BCVA. Moderate visual impairment seen in 2 cases which were diagnosed as having CME at postoperative one month and treated with subtenon injection triamcinolone acetonide which resolved by postoperative 3 months.

In present study, the mean AMT(Average macular thickness) was 257.21. Post-operatively at 1 month, the mean AMT was 267.85. Post-operatively at 3 month, the mean AMT was 263.7. There is increase in AMT at postoperative 1 month from preoperative AMT and the difference was statistically significant (p value 0.003).

Table 5: Comparison of preoperative and postoperative AMT according to type of surgery.

AMT	Pre-operative	Post-operative 1 month	Post-operative 3 month	ANOVA test P value
Phacoemul-sification(31)	261.18±12.66	269.42±19.70	266.14±11.34	0.009
SICS (33)	253.48±17.26	266.38±12.47	261.88±13.4	0.001

There is increase in AMT from preoperative at 1 month postoperative in both the groups (phacoemulsification and SICS) which gradually resolves by 3 months postoperative and difference is statistically significant.

Comparison of AMT at 1 month and 3 month postoperative period between group 1 and group 2 is statistically not significant (p value 0.12 and 0.36 respectively).

Discussions

In our study, the mean age of the 31 patients who underwent the phacoemulsification procedure was 57.45 years while the mean age of 33 patients who underwent the SICS procedure was 59.69 years.

In Dr. Pragati Garg et al.[11] 2019 study, mean age of the 180 patients who underwent the phacoemulsification and SICS surgery was 58.11±12.16 years with maximum numbers of patients found between 55-65 years of age group which is comparable to our study.

In our study, 64 patients who underwent cataract surgery, the mean pre-operative CMT noted was 176.07 µ. Post-operatively, at the first month review, the mean CMT was 199.53 µ; while at the

third month review, the mean CMT was 177.64 µ;

There was subclinical increase in CMT at 1 month postoperative period which resolved by 3 month postoperative period, difference being statistically significant (p = 0.0005).

In Md. Kamal Hassan et al.[12] 2018 study, the mean pre-operative macular thickness was 198.67±27.42 µ, at 45 days the mean macular thickness was 221.32±28 .05µ and at 90 days it was 201.32±28.98 µ. This difference was significant statistically.

In our study we found increase in subclinical macular thickness at postoperative 1 month and which resolved by 3 month postoperatively which was statistically significant (p value 0.02) in both the groups phacoemulsification and SICS.

Comparison of CMT at 1 month and 3 month postoperative period between group 1 and group 2 is statistically not significant (t test p value 0.44 and 0.37 respectively).

There were two patients with clinical CME, one in group 1 (phacoemulsification) and other in group 2 (SICS). Clinical CME was observed at post-operative 1 month and resolved by 3 month post-operative after treatment with posterior subtenon injection of triamcinolone.

In Charu Chaudhary et al.[13] 2014 studyobserved that an increase in foveal thickness was detected from the first postoperative day with a peak at 1 week, which was maintained until 1 month and then decreasing to almost the preoperative values at 3 month postoperatively in both the groups. Comparison between group I and group II revealed that foveal thickness of group I was higher than group II at all the post-operative visits, which was not statistically significant at any of the visit. There were two patients with clinical CME in group I and one patient in group II. Thickness and cystoid spaces gradually decreased at 1 month and reached to normal values by 3 months postoperatively in all the patients.

In Md. Kamal Hassan et al.[12] 2018 study observed a higher value of macular thickness in SICS group on 45th day follow up as compared to PHACO group. Macular thickness difference between PHACO and SICS found to be highest on 45th day of follow up with statistical significant (p = 0.001).The values resolved to near normal during the final follow up at 180th day with a value of 194.74±29.05 in SICS and 190.26±26.58 in PHACO group.

In our study, the mean post-operative best corrected visual acuity at 1 month was 0.72±0.21 (decimal) (approximately 6/9, 0.2 logMAR) and at 3 month was 0.85±0.18 (decimal) (approximately 6/6, 0.05 logMAR). A statistically significant difference was observed between 1 month and 3 month BCVA (p value 0.0002). (Moderate visual impairment seen in 2 cases which were diagnosed as having CME at postoperative one month and treated with subtenon injection triamcinolone acetonide which resolved by postoperative 3 months)

In Supriya Dhar et al.[14] 2019 study, best corrected visual acuity (BCVA) at four, eight, and twelve weeks after uncomplicated cataract surgery was 0.1 logMAR, 0.05 logMAR and 0.01 logMAR respectively. A statistically significant difference was observed between BCVA at day (28 v/s 56) and (28 v/s 84) respectively. However, there was no significant difference between BCVA at day (56 v/s 84).

In Dr. Pragati Garg et al.[11] 2019 study, the mean post-operative best corrected visual acuity at 1 month was 0.28 logMAR and post-operative best corrected visual acuity at 3 month was 0.15 logMAR.

In the present study, 31 patients who underwent PHACO, the mean postoperative best corrected visual acuity at one month was 0.75 decimal (approximately 6/9, 0.1 LogMAR) and at the third month was 0.88 decimal (approximately 6/6, 0.05 LogMAR). While in the 33 patients who underwent SICS, the mean postoperative visual acuity at one month was 0.69 decimal (approximately 6/9, 0.2 LogMAR) and at the third month was 0.83 decimal (approximately 6/6, 0.1 LogMAR). A statistically significant difference was observed between 1 month and 3 month BCVA in both the groups; phacoemulsification (p value 0.0009) and SICS (p value 0.003).

Comparison of BCVA at 1 month postoperative period between group 1 and group 2 is statistically not significant (p value 0.39). Comparison of BCVA at 3 month postoperative period between group 1 and group 2 is statistically not significant (p value 0.31).

This is because, uncomplicated SICS surgery has comparable visual outcome to phacoemulsification.

In Charu Chaudhary et al.[13] 2014 study, observed that the mean postoperative best corrected visual acuity at post-operative day one, 1 and 3 months in group 1 SICS was 0.04, 0.00, and 0.05 logMAR respectively. Similar results were found in group II phaco at day one, 1 and 3 months was 0.10, 0.03, 0.03 logMAR respectively which was statistically not significant.

In Dr. Pragati Garg et al.[11] 2019 study, observed that the mean postoperative best corrected visual acuity of PHACO at one month was 0.30±0.26 logMAR and at the third month was 0.17±0.24 logMAR. While in SICS at one month was 0.26±0.22 logMAR and at the third month was 0.13±0.20 logMAR which was statistically not significant.

In our study, the mean AMT was 257.21. Post-operatively at 1 month, the mean AMT was 267.85. Post-operatively at 3 month, the mean AMT was 263.7. There is increase in AMT at postoperative 1 month from preoperative AMT and the difference was statistically significant (p value 0.003).

In study of Dr. Pragati Garg et al.[11] 2019 observed that the percentage change in average macular thickness between the first postoperative day and fourth week postoperatively and also between 1st postoperative day and twelve week postoperatively, was statistically significant with p-value <0.001 and P= 0.010 respectively.

However patients who participated in the study were not compliant for frequent follow up of OCT. Study results emphasize the need to investigate further with a larger sample size and longer duration of follow up necessary for further analysis of change in postoperative macular thickness in uneventful cataract surgery.

Conclusion

There is subclinical increase in macular thickness at 1 month postoperative period which resolves by 3 month postoperative period in both the groups (phacoemulsification and SICS) after uneventful cataract surgery.

However increase in subclinical macular thickness has no effect on BCVA.

Clinically pseudophakic cystoid macular edema is seen in 2 patients (3%) in our study which suggests that in uneventful cataract surgery there are less chances of development of cystoid macular edema.

Variables like age, sex, duration of surgery, type of surgery has not been proved statistically significant difference in our study.

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