

Postsurgical Retinal Nerve Fiber Layer and Macular Thickness Analysis by Optical Coherence Tomography In Hypermature Cataract of Presenile Patients

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Abstract

Purpose: To study the changes in retinal nerve fiber layer (RNFL) and fast macular thickness (FMT) after cataract surgery in presenile patients with hypermature cataract.

Methods: It was a clinical randomized study in 157 eyes of 157 patients who underwent uneventful cataract surgery with intraocular lens (IOL) implantation performed by a single surgeon. All patients were aged between 40-55 years. One group underwent phacoemulsification (PHACO) procedure and the other group underwent small incision cataract surgery (SICS) procedure. The operated eyes were examined on the preoperative day, 1st postoperative day, 2nd week, 6th week, 12th week and 24th week after surgery using FMT and RNFL protocol of optical coherence tomography (OCT). Patients having any other eye diseases were excluded from the study.

Results: Macular thickness after PHACO and SICS were found to be highest at 6th post operative week, with a mean average value of $227.45 \pm 26.46 \mu\text{m}$ and $206.71 \pm 25.36 \mu\text{m}$ in SICS and PHACO group respectively. Small incision cataract surgery group had significantly higher thickness than the phacoemulsification group ($p=0.001$). Difference of RNFL thickness between PHACO and SICS was found to be highest during 6th week follow up ($p=0.001$), with a mean average value of $94.65 \pm 16.82 \mu\text{m}$ and $92.21 \pm 16.66 \mu\text{m}$ respectively.

Conclusion: This novel study reveals that surgery on hypermature cataract of presenile patients affects the RNFL and macular thickness. These changes are highest during the 6th postoperative week, resolving gradually towards the 24th postoperative week. There is a significant difference in postoperative increase in macular and RNFL thickness between SICS and phacoemulsification surgery procedures, both being significantly higher in the SICS group than the phacoemulsification group, the highest difference being at 6th postoperative week. It indicates PHACO to be a preferable surgery in presenile hypermature cataract with regard to postoperative increase in macular and RNFL thickness.

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Keywords: Macular thickness, RNFL, OCT, Cataract surgery, Presenile hypermature cataract

Introduction

Cataract is a major cause of avoidable blindness worldwide.^{1,2,3,4} Common procedures for cataract surgery are small incision cataract surgery (SICS) and phacoemulsification (PHACO). During and after the procedure of cataract surgery, there might be changes in the macular thickness and the retinal nerve fiber layer thickness, which may have deleterious effect on visual outcome. Cystoid macular edema (CME) is a problem not uncommon after cataract surgery.⁵ Published reports show that CME occur in about 2% of healthy population after cataract surgery.⁶

Optical Coherence Tomography (OCT) is a method of imaging in vivo to evaluate ocular tissue. It provides us with precise measurement of macular and retinal thickness. It gives us scope for diagnosis, monitoring and therapeutic approach to many retinal diseases and glaucoma. Optical Coherence Tomography is a noncontact, non-invasive, easily reproducible method that uses only light.

Phacoemulsification, in cataract surgery, allows us to use vacuum to finish the operation quickly similar to aspiration and irrigation of SICS procedure. But, variation of intraocular pressure (IOP) may occur with transient rise or fall of IOP resulting in changes of macular and RNFL thickness.

The effect of cataract surgery on RNFL and macular thickness causing their alteration has been shown in a few published reports.^{5,7} These studies had their limitations because all these studies analysed only senile immature cataracts or nuclear sclerotic cataracts. None of these studies included presenile cataracts as these forms of cataracts are seldom found in developed countries.⁸

Another shortcoming of these studies was non-inclusion of hypermature cataract. Knowledge of analysis of RNFL and macular thickness following cataract surgery in hypermature cataract may change the dimensions of management of such cataracts. If this hypermature cataract be in presenile patients, it will give added knowledge to cataract management system. This study investigated the effect of cataract surgery on macular and RNFL thickness exclusively in hypermature cataracts in presenile patients of age group 40-55 years. It is the first research work on presenile hypermature cataract. It is also the first study on macular and RNFL thickness in hypermature cataract.

Materials and Methods

This study was conducted in Regional Institute of Ophthalmology, Gauhati Medical College and Hospital,

Guwahati. It included 157 eyes of 157 patients. Stratus 3000 OCT (Carl Zeiss Meditec, Inc.) was used for measuring the thickness of retinal nerve fiber layer and the macula. One of the trained and experienced optometrist performed OCT in all the eyes under evaluation on preoperative day and on 1st day, 2nd week, 6th week, 12th week and 24th week after surgery.

The contralateral eye had immature cataract or no cataract. Since we could not take preoperative OCT evaluation readings in the eye with hypermature cataract, we took the other eye as the normal eye and the OCT value of this eye was taken to be equivalent to the preoperative data of the operated eye. However, in some patients both eyes had hypermature cataract and we excluded these cases from the study. Patients having any systemic disease, other ocular diseases, ocular trauma, history of previous ocular surgery and patients with age below 40 years and above 55 years were excluded from the study. One eyed patients were not included in the study.

An informed written consent was obtained from each patient after explaining the protocol of the research. Only eyes with axial length 22-25 mm, anterior chamber depth 3-4 mm and intraocular pressure 10-22 mm Hg were included for this study.

Amongst the selected cases for the study, all types of hypermature cataracts were included including solid, liquid and shrunken. However, complications of hypermaturity like lens induced glaucoma, uveitis were excluded. Patients with only uneventful cataract surgery and patients with no intraoperative or postoperative complications were included in the study.

All selected cases underwent either SICS or PHACO procedure by a single surgeon with sufficient experience in cataract surgery. The surgeries were performed under peribulbar anaesthesia. Trypan blue assisted continuous curvilinear capsulorhexis (CCC) was created in each case. In the SICS procedure, a 6 mm frown incision was made on the superior or temporal sclera and 1.5 mm posterior to the limbus. The nucleus was then delivered by the sandwich technique. Implantation of a hydrophobic acrylic lens (Alcon, AcrySof IQ) in the capsular bag was done in all cases. The self-sealing wound was left unsutured. A 2.8 mm corneal tunnel incision was made in the phacoemulsification procedure. Phacoemulsification was done using an Infinity vision system (Alcon, Inc.) with stop-and chop technique. Hydrophobic acrylic lens (Alcon, AcrySof IQ) was implanted in the capsular bag.

Postoperatively, a tapering dose of steroid drops (prednisolone acetate) was used for six weeks, Moxifloxacin eye drop for 2 weeks and Nepafenac eye drop for three months. No systemic medications was used pre and postoperatively.

Statistical analysis was performed using SPSS v 15 (SPSS Inc, Chicago, IL, USA). Paired sample t - test was used to compare the FMT and RNFL parameters.

This study was approved by the Ethics Committee of Gauhati Medical College, Guwahati, and complied with the tenets of the Declaration of Helsinki for research involving human tissue.

Results

The study group included 157 eyes of 157 patients; 81 underwent SICS and 76 underwent phacoemulsification procedure, 64 were males and 93 were females, whose average age was 48.63 ± 4.26 years. In this study, 40 patients were in the age group 40-45 years, 66 were in the age group 46-50 years and 51 patients were in the age group 51-55 years. A higher value of macular thickness was observed in the SICS group during follow up. The difference in macular thickness between phacoemulsification and SICS was found to be highest during the 6th week follow up with statistically significant difference ($p=0.001$), SICS group showing thickness of $227.45 \pm 26.46 \mu\text{m}$ and PHACO group $206.71 \pm 25.36 \mu\text{m}$. In both the groups, the values resolved to near normal during the final follow up at 24th week with a value of $194.93 \pm 29.79 \mu\text{m}$ in SICS and $186.56 \pm 22.04 \mu\text{m}$ in phacoemulsification (Figure 1) (Table 1).

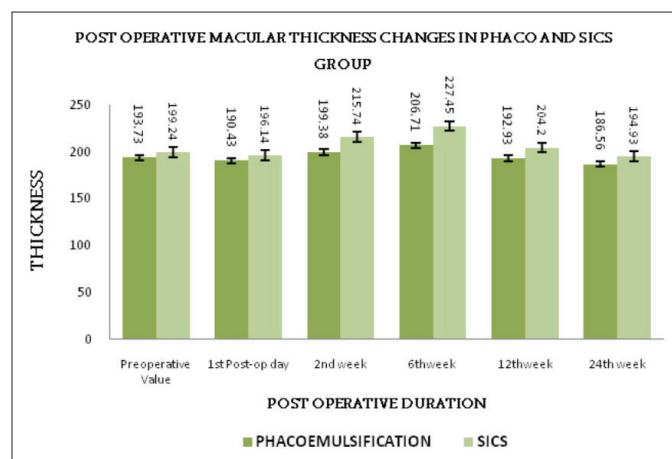


Figure 1: Comparison of macular thickness in SICS group and phacoemulsification group

Table 1: Comparison of macular thickness between two surgical groups (Thickness in μm).

Time after surgery	Phacoemulsification (Mean ± SD)	SICS (Mean ± SD)	P-value
Preoperative value	193.73±22.15	199.24±28.95	0.07
Day 1	190.43±24.22	196.14±31.79	0.004
2nd Week	199.38±24.37	215.74±26.28	0.003
6th Week	206.71±25.36	227.45±26.46	0.001
12th Week	192.93±23.63	204.20±29.70	0.001
24th Week	186.56±22.04	194.93±29.79	0.005

SD: Standard Deviation.

A higher value of RNFL thickness was observed in SICS group during follow up. The difference in RNFL thickness between phacoemulsification and SICS was highest and very significant ($p=0.001$) during the 6th week follow up with a mean value of $94.65 \pm 16.82 \mu\text{m}$ in SICS and $92.21 \pm 16.66 \mu\text{m}$ in phacoemulsification group. In both the groups, the values resolved to normal during the 24th week follow up with RNFL thickness of $86.61 \pm 15.86 \mu\text{m}$ in the SICS group and $84.16 \pm 15.58 \mu\text{m}$ in the phacoemulsification group (Figure 2) (Table 2).

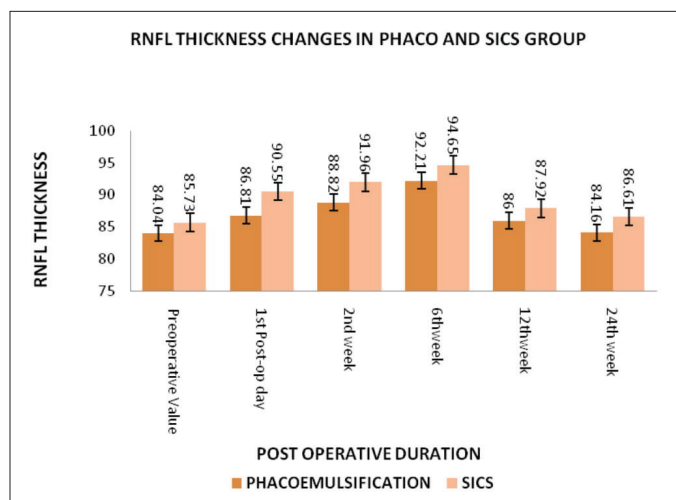


Figure 1: Comparison of macular thickness in SICS group and phacoemulsification group

Table 2: RNFL thickness in SICS and phacoemulsification group. (Thickness in µm).

Time after surgery	Phacoemulsification (Mean ± SD)	SICS (Mean ± SD)	P-value
Preoperative value	84.04±13.83	85.73±14.07	0.05
Day 1	86.81±16.19	90.55±17.12	0.006
2nd Week	88.82±16.54	91.96± 16.70	0.003
6th Week	92.21±16.66	94.65±16.82	0.001
12th Week	86.00±15.90	87.92±16.04	0.002
24th Week	84.16±15.58	86.61±15.86	0.005

RNFL: Retinal Nerve Fiber Layer
SD: Standard Deviation.

We found a significant difference in the RNFL thickness between the two groups on the first postoperative day, on 2nd week, 6th week, 12th week and 24th week after surgery. The results of our study show that both RNFL and macular thickness increase from the first postoperative day to 6th postoperative week, then gradually decrease to near normal level in 24 weeks.

Discussion

Optical Coherence Tomography is a non-invasive test which helps in accurate studies of macular pathology. It helps us to better understand the structural changes in the retina of the posterior pole after surgical procedures. Measurements with OCT have been found to be precise, accurate, reproducible and repeatable.^{7,9,10,11,12} Hypermature cataract is that condition where the entire lens cortex becomes opaque. It becomes either soft liquid or solid and shrunken. In developed countries, hypermature cataract is found only in the literature. However, this form of cataract is very commonly found in third world countries. It is also important that it is not uncommon in the patients of presenile age group (40-55 years) in India. Our study shows that macular and RNFL thickness increases postoperatively, which get resolved with time. Though the resultant alteration in macular and RNFL thickness is trivial,

it has got tremendous impact on the cataract management protocol indicating that cataract has to be removed before it reaches to hypermature stage. As there was significant difference in these parameters between PHACO and SICS group, with PHACO group having lesser alterations during the early post operative period, PHACO seems to be a better choice for cataract management in hypermature cataracts.

In a study, Ching et al. found a significant difference in foveal thickness and central retinal thickness during 4th and 8th weeks after surgery while compared with the data prior to surgery.¹³

In another study on peripapillary RNFL thickness, El-Ashry et al. found a statistically significant increase in the average RNFL thickness one month after completion of phacoemulsification surgery on 24 patients.¹⁴ They found good signal quality after one month of surgery.

In a similar study, Biro et al. found no significant increase in retinal or foveal thickness on the day after surgery.¹⁵ However, 30 days after the procedure, the increase was found to be significant.

French authors Sourdille and Santiago found increased macular thickening and decreased Visual Acuity in 11 eyes out of 41 patients after uncomplicated cataract extraction.¹⁶ However, postoperative macular oedema was explained by the damage of blood-retinal barrier.^{17,18}

Ghosh et al studied 224 patients with senile cataract and found that postoperatively, the central subfield mean thickness of retina increases in SICS compared to phacoemulsification.¹⁹

All these studies evaluated different aspects of retinal thickening in senile cataract patients postoperatively. However, there is no published report on the analysis of macular and RNFL thickness in patients undergoing surgical intervention for presenile hypermature cataract. Third world countries at large, and India in particular, do have a large number of patients with presenile hypermature cataract. Research work on the eyes of these patients was the primary focus of this study.

Conclusion

This novel study reveals that surgery on hypermature cataract of presenile patients affects the RNFL and macular thickness. These changes are highest during the 6th postoperative week, resolving gradually towards the 24th postoperative week.

There is a significant difference in postoperative increase in macular and RNFL thickness between SICS and phacoemulsification surgery procedures, both being significantly higher in the SICS group than the phacoemulsification group, the highest difference being at 6th postoperative week. It indicates PHACO to be a superior surgery in presenile hypermature cataract with regard to postoperative increase in macular and RNFL thickness.

Increasing the number of patients and follow up for a longer duration will bring results of a more accurate study. Lack of proper imaging instruments to analyze retinal structures and thickness through a completely opaque media is the limitation of this study. Invention of such an instrument will be more informative in such situations.

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