Comparative Evaluation of Macular Changes using Optical Coherence Tomography (OCT) following uneventful Cataract Surgery and Cataract Surgery Complicated with Posterior Capsule Rent - A Case-Control Study

Battula Yallamanda Babu Rao[1], Vairagyam Rajalingam[2], Pachalla Sai Rupa Sree[3]

ABSTRACT

Introduction: The World Health Organization estimates that the current global prevalence of blindness is 0.57% (range: 0.2%–1%), with more than 82% of all blindness occurring in individuals aged 50 and older. 3.8 million persons become blind from cataract each year in India. The aim of the current study was to determine macular thickness changes after uncomplicated cataract surgery and in cataract surgery complicated with posterior capsule rent using spectral domain optical coherence tomography (OCT).

Material and Methods: This was a prospective case-control study. Out of 60 patients, 30 patients complicated by posterior capsular rent were taken as cases on a continuance basis and 30 patients of uncomplicated cataract surgery as controls as a convenience non random sampling method. OCT measurements were performed before surgery and postoperatively at day 1, week 1 and 6. Post operatively, slit lamp examination was done on the first day and in further follow ups. BCVA was recorded using Snellen's chart on the post-operative 1st day, 1st week and 6th week. This was later converted to LogMAR visual acuity for statistical analysis.

Results: CME was diagnosed when there was increase in central macular thickness by more than or equal to 40% increase from baseline. 2 patients in controls (Group 1) had an increase of central macular thickness by 16% from baseline but none of the patients in controls (Group 1) developed CME. Out of the 30 patients in cases (Group 2), 4 patients developed CME changes.

Conclusion: Mean macular thickness values measured using OCT were found to be significantly high in eyes which underwent cataract surgery complicated with posterior capsule rent when compared to the eyes which underwent uneventful cataract surgery.

Keywords: Macular Thickness, Phacoemulsification, Spectral Domain Optical Coherence Tomography, Cystoid Macular Oedema

Introduction

Cataract is the leading cause of blindness in the world and the most prevalent ocular disease. With the advancement in surgical methods and instrumentation, the visual outcome following cataract surgery has become much better. Phacoemulsification and implantation of a foldable intraocular lens (IOL) is currently the preferred technique of surgery among cataract surgeons.[1]

The term cataract refers to opacity of any part of the crystalline lens which is normally almost completely transparent. Cataract accounts for 47.8% of the world's roughly 37 million blind individuals. Of note, approximately 90% of the contribution of cataract to blindness was seen in developing countries. The visual outcome of cataract surgery depends upon various factors like condition of the cornea, type of cataract, manipulation of iris, presence of pre-existing ocular conditions like chronic uveitis, any associated systemic disease, and occurrence of intra-operative complications and also experience of the surgeon.[2]

The World Health Organization estimates that the current global prevalence of blindness is 0.57% (range: 0.2%–1%), with more than 82% of all blindness occurring in individuals aged 50 and older. Approximately, 3.8 million people become blind from cataract each year in India.[3]

In 1953, Irvine described cystoid macular edema (CME) that specifically arised after cataract surgery. It is the most common cause of unexpected visual loss after cataract surgery. The American Academy of Ophthalmology Preferred Practice Patterns defines Cystoid Macular Edema (CME) as retinal thickening of the macula due to disruption of the normal blood-retinal barrier; which causes leakage from the perifoveal retinal capillaries and accumulation of fluid within the intracellular spaces of the retina, primarily in the outer plexiform layer.[4,5]

The pathogenesis of CME after cataract surgery is likely multifactorial, but inflammation caused by surgical manipulation appears to be the major cause. Inflammatory mediators break down the blood–aqueous and blood–retinal

[1]Assistant Professor, Sarojini Devi Eye Hospital, Osmania Medical College, Hyderabad, [2]Professor and Head of the Department of Ophthalmology, Sarojini Devi Eye Hospital, Osmania Medical College, Hyderabad, [3]Postgraduate Student, Sarojini Devi Eye Hospital, Osmania Medical College, Hyderabad, India

Corresponding author: Dr. Battula Yallamanda Babu Rao M.S., D.O., #106, Block-A, Shweta Aryan Apartments, Pipeline Road, Jeedimetla, Quthbullapur Mandal, Hyderabad, Telangana. ---500067, India

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barriers, leading to increased vascular permeability.

Postoperative cystoid macular edema (CME) represents a well-known entity associated with a variety of intraocular operations and is the commonest cause for suboptimal vision after cataract surgery. CME is more common after operations such as intra capsular cataract extraction, scleral buckling, pneumatic retinopexy, combined penetrating keratoplasty and trans-scleral sutured posterior chamber IOL implantation.[6,7]

Posterior capsule rent (PCR), reported to occur in 0.5% to 7.5% of cases is a significant potential complication of cataract surgery. PCR, with or without vitreous disturbance leads to increased incidence of hyphema, increased persistent post-operative inflammation, retained cortex, corneal edema, post-operative endophthalmitis, cystoid macular edema (if chronic leading to macular pseudoholes) and tractional retinal detachment in long standing cases.

The principles and type of cataract surgery have evolved over the past few decades. Manual small-incision cataract surgery (MSICS) is a cost-saving procedure and is suitable for developing countries. MSICS is significantly faster, less expensive, and less dependent on technology than phacoemulsification.[8,9]

Although 16 to 30% of patients who have undergone uncomplicated extracapsular cataract surgery will show signs of cystoid macular edema (CME) on fluorescein angiography, few will experience a significant effect on their vision, and less than 2.5% will suffer a permanent visual deficit as a result.[10,11]

Still, CME is the most common cause of unexpected poor vision following cataract surgery.

Optical Coherence Tomography (OCT) offers a non-invasive imaging technique that provides high resolution cross sectional images of the macula. CME in OCT appears as a collection of hypo-reflective spaces within the retina, with an overall increase in macular thickening and loss of the foveal depression. OCT is as effective as FFA at detecting macular edema, while it produces highly reproducible measurements so that serial examination may be used for follow up.[12]

Cystoid macular oedema (CMO), although infrequent with the advent of phacoemulsification, is still a main cause of unfavorable visual outcome after uneventful cataract surgery. Although the exact mechanism is not known, the role of surgical trauma with release of prostaglandins and blood retinal barriers disruption is suspected. Light toxicity and vitreo-macular traction may also have a role.[13] Hence, the aim of the present study was to evaluate and compare the macular changes using OCT after uneventful cataract surgery and cataract surgery complicated with posterior capsule rent.

MATERIAL AND METHODS

This was a case-control study which was conducted for a period of two years from October 2015 to October 2017. The ethical permission was obtained from Institutional ethics committee before starting the study. Informed consent was obtained from all the participants. The study was conducted on 60 patients who underwent manual small incision cataract surgery at Sarojini Devi Eye Hospital, Telangana.

Out of 60 patients, 30 patients who had posterior capsule rent during cataract surgery were taken as cases and 30 patients who had uneventful cataract surgery as controls. Patients with lenticular opacities of any grade admitted in Sarojini Devi Eye Hospital for manual small incision cataract surgery were included in the study. Patients with pre-existing macular diseases, patients with traumatic and complicated cataracts, patients with diabetes mellitus, patients with history of previous ocular surgeries in the same eye, patients on topical prostaglandins, pilocarpine and other medications known to cause cystoid macular edema were excluded from the study.

30 patients who underwent uneventful manual small incision cataract surgery served as controls (Group 1). 30 patients whose manual small incision cataract surgeries were complicated with posterior capsule rent served as cases (Group 2). All the patients included in the study were thoroughly evaluated for best corrected visual acuity (BCVA), refraction, slit lamp biomicroscopy, posterior segment evaluation, intra ocular pressure recording, axial length, keratometry and intra ocular lens power calculations were done.

Post operatively, slit lamp examination was done on the first day and in further follow ups. BCVA was recorded using Snellen's chart on the post-operative 1st day, 1st week and 6th week. This was later converted to LogMAR visual acuity for statistical analysis. Macular changes were evaluated using SD-OCT (Zeiss Cirrus HD – OCT) on the post-operative 1st week and 6th week in the study population. The post-operative macular changes on OCT imaging were compared between the two groups and conclusions were drawn.

All post-operative patients were given topical steroids 6 times a day for one week and then gradually tapered over the next 5 weeks; topical antibiotics 4 times a day and topical cycloplegics 2 times a day for two weeks. Patients detected to have CME were treated additionally with topical NSAIDS.

OCT imaging technique

All the eyes were dilated before OCT examination. All the scans were centred on fovea. The SD- OCT used in the study had an axial resolution of 10 µm. The retinal thickness values were measured in nine regions divided on the horizontal and vertical meridians around the macular fovea. The central foveal thickness was measured in the central 1mm area. The inner concentric ring (parafovea) ranged from 1 to 3 mm from the central fovea and consisted of the following regions: inner- superior, inner-inferior, inner nasal and inner temporal. The outer concentric ring (perifovea) ranged from 3 to 6 mm from the central fovea and consisted of the following regions: outer superior, outer inferior, outer nasal and outer temporal.

STATISTICAL ANALYSIS

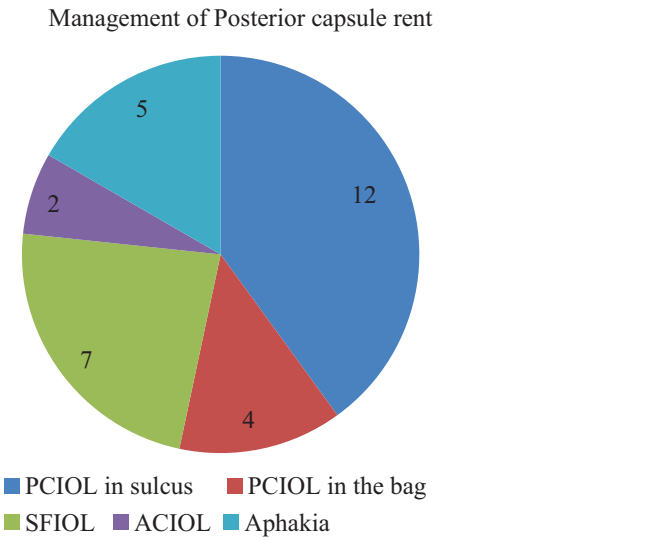
The mean and standard deviations of various parameters were calculated for both the groups. Student's t-test was used to compare the values between the two groups. 95% confidence interval (p value < 0.05) was considered as statistically significant difference between the two groups.

Age group	Male	Female	N=30
40-49 years	2	5	7
50-59 years	2	5	7
60-69 years	10	2	12
70-79 years	2	1	3
80-89 years	0	1	1
Total	16	14	30

Table-1: Shows distribution of controls based on age in Group 1

Age group	Males	Females	N = 30
40-49 years	1	2	3
50-59 years	4	7	11
60-69 years	9	3	12
70-79 years	3	0	3
80-89 years	1	0	1
Total	18	12	30

Table-2: Shows distribution of cases based on age in Group 2



Graph-1: Shows management of posterior capsule rupture in cases (Group 2)

	Mean pre- operative LogMAR BCVA	Mean LogMAR BCVA on 1st post-operative day	Mean LogMAR BCVA at 1st post-operative week	Mean LogMAR BCVA at 6th post-operative week
Controls (Group 1)	1.55 ± 0.35	0.46 ± 0.17	0.19 ± 0.12	0.10 ± 0.10
Cases (Group 2)	1.63 ± 0.35	1.10 ± 0.43	0.95 ± 0.53	0.75 ± 0.72

Table-3: Shows comparison of mean LogMAR BCVA between controls (group 1) and cases (group 2)

Parameter	Mean value in Controls (Group 1) in µm	Mean value in Cases (Group 2) in µm	p value
CFT	245.30 ± 18.33	247.53 ± 17.99	0.64
IS	315.70 ± 16.42	316.27 ± 14.72	0.89
IN	312.27 ± 18.54	313.93 ± 34.08	0.81
II	310.03 ± 14.40	312.67 ± 27.55	0.64
IT	300.30 ± 9.73	305.90 ± 28.58	0.31
OS	273.93 ± 16.98	276.70 ± 19.65	0.56
ON	290.03 ± 19.11	287.37 ± 40.28	0.74
OI	263.37 ± 17.53	265.13 ± 24.34	0.75
OT	257.60 ± 14.49	260.60 ± 19.78	0.50

Table-4: Shows comparison of macular thickness in OCT between controls (Group 1) and cases (Group 2) at post-operative 1st week

Parameter	Mean value in controls (Group 1) in µm	Mean value in cases (Group 2) in µm	p value
CFT	258.63 ± 12.36	290.93 ± 31.89	<0.0001
IS	326.03 ± 14.38	361.30 ± 26.13	<0.0001
IN	324.67 ± 14.38	348.20 ± 24.68	<0.0001
II	322.90 ± 13.51	352.47 ± 18.04	<0.0001
IT	306.60 ± 13.01	334.13 ± 35.30	0.0002
OS	292.50 ± 15.42	313.23 ± 25.06	0.0003
ON	307.03 ± 18.38	325.17 ± 38.08	0.0222
OI	272.03 ± 11.31	285.73 ± 27.40	0.0141
OT	271.20 ±16.97	292.40 ± 27.88	0.0008

Table-5: Shows comparison of macular thickness in OCT between controls (Group 1) and cases (Group 2) at post-operative 6th week

RESULTS

Out of the 30 patients in controls (Group 1), age of patients ranged from 40-89 years. Most of the patients belonged to the age group 60-69 years (12 patients). The mean age of the patients in this group was 58.17 ± 9.44 years (Table no. 1). Most of the patients belonged to the age group 60-69 years (12 patients). The mean age of the patients in this group was 60.13 ± 8.14 years (Table no. 2).

The mean pre-operative LogMAR BCVA of the controls (Group 1) was 1.55 ± 0.35. Mean pre-operative LogMAR BCVA of the cases (Group 2) was 1.63 ± 0.35. There was no statistically significant difference (p value = 0.38) between the two groups in terms of pre- operative BCVA. The mean LogMAR BCVA on the 1st post-operative day in controls (Group 1) was 0.46 ± 0.17 and that of cases (Group 2) was 1.10 ± 0.43. This was statistically highly significant difference between the two groups. (p value < 0.0001). The mean LogMAR BCVA at 1st post-operative week in controls (Group 1) was 0.19 ± 0.12 while that in cases (Group 2) was 0.95 ± 0.53. The mean LogMAR BCVA at 6th post-operative week in controls (Group 1) was 0.10 ± 0.10 while that in cases (Group 2) was 0.75 ± 0.72 (Table no. 3).

In Table no. 4 comparison of macular thickness in OCT was done between controls (Group 1) and cases (Group 2) at post-operative 1st week. In OCT following parameters were considered such as Central Foveal Thickness (CFT) which was increased in Group 2 and was not found to be statistically significant. Inner Superior (IS) was slightly increased followed by IN (Inner Nasal) and II (Inner

Inferior). IT (Inner Temporal) and OS (Outer Superior) was also increased in Group 2 followed by OI and OT which was also not found to be statistically significant. Only ON (Outer Nasal) was found to be decreased in Group 2 which was not found to be statistically significant.

In Table no. 5 comparison was done for macular thickness in OCT between controls (Group 1) and cases (Group 2) at post-operative 6th week. Central Foveal Thickness (CFT) was increased in Group 2 followed by Inner Superior (IS), Inner Nasal (IN) and Inner Inferior (II) which was found to be highly statistically significant. In group 2, Inner Temporal (IT) was increased followed by Outer Superior (OS) which was also highly statistically significant. Outer Nasal (ON) and Outer Inferior (OI) followed by Outer Temporal (OT) which was also found to be statistically significant.

In 30 cases, of group 2 where MSICS was complicated with posterior capsule rupture, anterior vitrectomy was done in all 30 cases following which PCIOL (posterior chamber intra ocular lens) was done in maximum number of cases followed by SFIOL (Sclera fixed Intra ocular lens) and Aphakia. ACIOL (Anterior Chamber Intra ocular lens) which was done is least number of cases.

CME was diagnosed when there was increase in central macular thickness by more than or equal to 40% increase from baseline. 2 patients in controls (Group 1) had an increase of central macular thickness by 16% from baseline but none of the patients in controls (Group 1) developed CME. Out of the 30 patients in cases (Group 2), 4 patients developed CME changes.

DISCUSSION

CME has been the most common cause of unexpected poor visual acuity after cataract surgery. The incidence increases when the degree of inflammation increases as in cataract surgery complicated with posterior capsule rent. There have been studies comparing macular thickness changes following uneventful phacoemulsification and phacoemulsification complicated with posterior capsule rent. But there are not many studies comparing these changes following manual SICS which is a commonly performed type of cataract surgery in developing countries like India. The present study compares the macular changes on OCT following uneventful and complicated (with posterior capsule rent) manual small incision cataract surgery.

SD-OCT (spectral domain OCT) was used to compare the post-operative macular changes following uneventful cataract surgery (manual SICS) and cataract surgery (manual SICS) complicated with posterior capsule rent. Macular thickness changes were analysed using OCT in the nine quadrants of the macula as described in Early Treatment Diabetic Retinopathy Study (ETDRS) i.e. central foveal; parafoveal (inner circle) - superior, nasal, inferior, temporal; perifoveal (outer circle) - superior, nasal, inferior, temporal. This analysis was done at the post-operative 1st week and post-operative 6th week in both the groups.

The macular thickness measurements on OCT at post-operative 1st week were found to be correlated with the normative data of macular thickness in healthy Indian eyes using SD-OCT. Hence, these values were taken as the baseline measurements for evaluating the macular changes in the present study. In the present study, an increase of macular thickness by more than or equal to 40% from baseline was considered as macular edema.

The mean central foveal thickness at 1st post-operative week in the controls (group 1) was 245.30 ± 18.33 µm and that in cases (group 2) was 247.53 ± 17.99 µm. There was no statistically significant difference between the two groups (p =0.64). The comparison of macular thickness at 1st post-operative week in the parafoveal and perifoveal areas between the two groups also did not show any statistically significant difference. This can be explained by the fact that CME and other macular changes take a minimum of 3 weeks to develop after an intra-ocular surgery.

At 6th post-operative week, the mean central foveal thickness in controls (Group 1) was 258.63 ± 12.36 µm and that in cases (Group 2) was 290.93 ± 31.89 µm. (P < 0.0001). There was a high statistically significant difference between the two groups.

In the present study, there was a statistically significant difference between the two groups in terms of mean thickness of central foveal, superior and temporal quadrants of parafoveal and perifoveal areas at the 6th post-operative week. This was consistent with the findings of the study by Akçay BİS, Bozkurt TK, Güney E, et al. In the present study, none of the patients in controls (Group 1) developed CME whereas the incidence of CME was 13.33% in the controls (Group 2). This was in correlation with the studies done by Akçay BİS, Bozkurt TK, Güney E, et al where none of the patients in Group 1 and 10% of Group 2 patients developed CME.[14]

In the present study, there was a significant difference in mean central foveal thickness at 6th post-operative week between the uneventful surgery group and complicated surgery group. This was in concordance with the findings of the study by Sarhan et al. In the present study, diabetics were excluded. Also, none of the patients in controls (Group 1) developed CME whereas the incidence of CME was 13.33% in the controls (Group 2). In the study done by Sarhan et al, the incidence of CME was 5.6% in the non-diabetics who underwent uncomplicated cataract surgery; 27.8% in non-diabetics and 50% in diabetics who underwent cataract surgery complicated with posterior capsule tear.[15]

In the present study, there was no statistically significant difference in pre-operative BCVA between the two groups. Post-operative BCVA of controls (Group 1 i.e. uneventful cataract surgeries) was significantly better than that of cases (Group 2 i.e. cataract surgery complicated with posterior capsule rent) at all intervals measured (i.e. post-operative 1st day, 1st week and 6th week). Poor visual outcomes in the earlier visits after complicated surgeries even before the development of CME can be attributed to the collateral damage in the anterior structures such as flare in anterior chamber, corneal edema, aphakia. A study done by Akçay BİS, Bozkurt TK, Güney E, et al found that the BCVA was

better after uneventful cataract surgeries than complicated ones during the follow-up period.[14]

The Limitations of the present study were flawless comparison was difficult after complicated cataract surgeries. Though anterior vitrectomy was done in all 30 cases, the type of IOL placed was not uniform in all the 30 cases. The sample size of the study was small. All the cases were followed up till the post-operative 6th week. Further studies with larger sample size and longer duration of follow-up would give better analysis of post-operative macular changes.

CONCLUSION

In the present study, mean macular thickness values measured using OCT at post-operative 6th week were found to be significantly high in eyes which underwent cataract surgery complicated with posterior capsule rent when compared to the eyes which underwent uneventful cataract surgery.

Mean BCVA at all intervals measured was found to be significantly better in eyes which underwent uneventful cataract surgery when compared to the eyes which underwent cataract surgery complicated with posterior capsule rent and the central foveal thickness at post-operative 6th week was found to be higher in eyes where ACIOL was implanted and in eyes which were left aphakic after cataract surgery complicated with posterior capsule rent. Longer duration of follow-up is necessary for further analysis of post-operative macular changes.

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