Original Research Article

A study to assess the macular thickness and visual outcome before and after cataract surgery

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ABSTRACT

Background: Cystoid macular edema (CME) is the formation of fluid-filled cystoid spaces between the outer plexiform and inner nuclear layers of the retina. It may present as a complication of routine cataract surgery including phacoemulsification (PHACO) and small incision cataract surgery (SICS).
Methods: An observational study of uncomplicated cataract surgery with assessment by ophthalmoscopy, slit Lamp, Snellen chart and OCT during pre- and post-operative period. 100 patients were selected by inclusion criteria and using convenient sampling technique and were divided into two groups of 50 each in PHACO and SICS groups.
Results: During preoperative observation in SICS/group-1, mean value and SD of macular thickness was 223.38±12.61 and in PHACO/group-2 it was 224.14±12.69. Mean value, mean difference and p value of visual acuity in group 1 was 0.258, during 12 weeks 0.788 with mean difference -0.53 and p=0.000 and in group 2 it was 0.269, during 12 weeks 0.844 with mean difference -0.58 and p=0.000. Mean value, SD, mean difference and p value of macular thickness in SICS during 1 week was 238.28±12.29, during 12 weeks 227.04±12.58 with mean difference 11.24000 and p=0.000 and in PHACO mean value, SD, mean difference with p value during 1 week was 231.90±12.42, during 12 weeks was 225.02±11.74 with mean difference 6.88000 and p=0.000.
Conclusions: A subclinical increase in post-operative macular thickness was recorded which returned nearly to baseline values during the 12 weeks follow up and did not affect visual outcome.

Keywords: PHACO, SICS, OCT, Macular thickness, CME

INTRODUCTION

The cystoid macular edema (CME) is defined as the formation of fluid-filled cystoid spaces between the outer plexiform and inner nuclear layers of the retina, which results from the disruption of the blood retinal barrier.[1]

It is one of the complications of routine cataract surgeries including phacoemulsification and small incision cataract surgery.[2]

Small incision cataract surgery

Construction of a little, self-sealing sclerocorneal tunnel for delivering the cataractous lens is the central principle in small incision cataract surgery (SICS), and therefore the procedure is often done using a temporal or a superior incision, whichever is more convenient.[3]

Phacoemulsification surgery

Phacoemulsification surgery (PHACO) is considered as a variation of extracapsular cataract extraction, a procedure

during which the lens and therefore the front portion of the capsule are removed.[4]

Charles Kelman created phacoemulsification in the late 1960s. His goal was to get rid of the cataract with a smaller incision, less pain and shorter recovery time. He discovered that the cataract might be broken up, or emulsified, into small pieces using the help of an ultrasound tip.[5]

Complications are unlikely, but can occur. Patients may experience spontaneous bleeding from the wound, recurrent inflammation, flashing, floaters and diplopia can also occur. Some can be easily treated, while others such as floaters may be a sign of a retinal detachment.[6]

Pseudophakic cystoid macular oedema (PCME) is a common complication of cataract and intraocular lens (IOL) surgery, manifesting as effusion of fluid from capillaries. Cystoid spaces form in macula due to the accumulation of serous fluid in the outer plexiform layer. this phenomenon is most often self-limiting, culminating in spontaneous resolution.[7]

Postoperative optical coherence tomography (OCT) imaging has shown increased macular thickness primarily involving perifoveolar region following cataract extraction and IOL implantation. This is clinically associated with decreased visual acuity measured 1 week after surgery.[8]

The OCT is a diagnostic imaging technique used in ophthalmology which can perform micron resolution, cross sectional or tomographic imaging in biological tissues.[9]

OCT uses low coherence or white light interferometery to perform high resolution measurements and imaging, it is predicated on the principal of Michelson interferometry.[10]

Most patients have restored visual acuity after surgery and a few patients will have the best vision of their lives after the insertion of IOLs. Some patients will not require the utilization of eyeglasses or contact lenses after cataract surgery. Patients will also have better colour and depth perception and be able to resume normal activities.[11]

Etiopathogenesis of CME

A break in the blood- aqueous barrier has been identified as the prime cause of PCME. Occurrence of CME is related to the synthesis of prostaglandins and other mediators. Surgical trauma leads to release of prostaglandins, which causes a break in the blood-aqueous barrier.[12]

Prostaglandins pass through the vitreous into the posterior segment and result in outpouring of serous fluid into the Henle's layer.[13]

While working in the department, it was observed that a few patients after undergoing cataract surgery did not show expected improvement in visual acuity. As the patients participating in the study had no systemic disease or any pre-existing ocular abnormality and their retina revealed no abnormality pre-operatively. The cause was suspected to be some post-surgical alteration in the retinal architecture. Since no study about such problem has been conducted in our institute previously and no such study has been done in the state of Punjab so far. This created interest in the present topic.

Aim and objectives

The aim of the present study is to assess the macular thickness and visual acuity before and macular thickness and visual outcome after cataract surgery and make comparison between the two observations.

Objectives of the study were to assess the macular thickness and visual acuity before cataract surgery, to assess the macular thickness and visual outcome after cataract surgery and to make comparison between the macular thickness and visual acuity before and after cataract surgery.

METHODS

Present study is based on observations by ophthalmoscopy, slit lamp, Snellen chart and OCT in uncomplicated cataract patients during pre and postoperative period. The patients were followed up on 1st post-operative day, after one week, after 4 weeks and after 12 weeks for visual acuity and for macular thickness measurement using OCT.

Study design

Study design was prospective comparative observational study.

Study group

The subjects are uncomplicated cataract patients and are selected as per inclusion criteria of the study. Total sample size being 100. The study subjects are divided into two groups of 50 each. Group 1 is SICS and group 2 is PHACO.

Study period

The study was carried out after getting approval from the research and ethical clearance committee. Data was collected from Jan, 2019-June, 2020.

Sampling technique

Convenient sampling technique was used to enrol the subjects and subjects were selected as per inclusion criteria.

Inclusion criteria

Inclusion criteria included patients ≥40-80 years of age, patients with uncomplicated cataract and patients who underwent SICS and PHACO without complications.

Exclusion criteria

Exclusion criteria excluded patients with diabetes mellitus, previous ocular surgery in the same eye, glaucoma or ocular hypertension, or any retinal disorder. Patients with ocular diseases that might influence macular thickness such as history of uveitis, diabetes, age-related macular degeneration, intraoperative complications, trauma cases and inferior quality measurements of OCT due to media opacities.

Clinical evaluation

A) Pre-operative examination consisted of the following: 1. Determination of best corrected visual acuity (BCVA) by Snellen's chart, 2. Fundus examination by direct ophthalmoscopy after dilatation of pupils, 3. Slit lamp examination of the anterior segment and for assessment of type of cataract, 4. Slit lamp bio-microscopy of fundus using +90D lens and 5. OCT retinal thickness analysis.

Other routine examinations included determination of: 1. Intraocular pressure (IOP) by non-contact tonometry (NCT), 2. Axial length using the A-scan, 3. Automated refractor (AR) and 4. General examination

B) Peri-operative examination consisted of noting the following points: 1. Type of surgery, namely phacoemulsification or SICS and 2. Absence of surgical complications.

C) Post-operative examination included the following: 1. Determination of the best corrected visual acuity (BCVA) by Snellen chart, 2. Slit lamp examination, 3. Intraocular pressure (IOP) by non-contact tonometry (NCT) and 4. OCT to determine the macular thickness.

Surgical technique

Patients who underwent phacoemulsification using a 2.8 mm superior or supertemporal scleral tunnel incision with a divide and conquer technique. A foldable acrylic intraocular lens was inserted in the capsular bag at the end of surgery. Patients who underwent manual small incision cataract surgery using a 6.0 or 7.0 mm superior or supertemporal scleral tunnel incision. Nucleus was removed using the irrigating vectis technique. A 6.0 mm PMMA single piece of intraocular lens was implanted in the bag at the end of surgery.

Examination of patient's eyes by OCT

Each eye of every subject was dilated with 0.5% tropicamide and 5% phenylephrine hydrochloride. The patient was seated comfortably in front of the OCT machine (NIDEK 3000) with chin positioned on the chin rest, and was asked to fixate on the fixation target and scan was done. Retinal thickness was quantitated by the computer for each scan in the image as the distance between the first reflection at the vitreoretinal interface and the anterior boundary of the red reflective layer corresponding to the retinal pigment epithelium and choroidal capillaries.

Interpretation of the oct scans

The reflectivity pattern was studied.

A) Hyper reflectivity patterns: Suggests presence of hard exudates, hyper reflective shadows in the neurosensory retina that completely blocked the reflections from the underlying retina, blood: If a thin layer, this was hyperreflective whereas a thick layer was found to block the underlying reflections, scar tissue and neovascular membranes (showed varying hyper reflectivity);

B) Hypo reflective patterns: suggests presence of serous fluid, optically empty space with absence of backscattering, cystoid spaces in the retina.

Statistical analysis

Data from this study was systematically collected, compiled and statistically analyzed using the SPSS statistics 26 version to draw the necessary conclusions. Collected data was arranged and master data sheet was prepared. Collected data was arranged in tables, figures and was analyzed by applying statistical methods i.e., percentage, mean value, mean difference and T test and results were interpreted.

RESULTS

In the group 1, maximum number was in age group of 51-60 years and least number in age group of 71-80 years. Mean age was 58.74±9.65. In the group-2, maximum number in age group of 61-70 years and least number in age group of 71-80. Mean age was 58.62±9.65 with p=0.953. There was no significant difference (Table 1).

Table 1: Age distribution in study groups.

Age (years)	SICS		PHACO	
	N	%	N	%
≤50	11	22	12	24
51-60	20	40	15	30
61-70	15	30	19	38
71-80	4	8	4	8
Mean age	58.74±9.65		58.62±10.57	
P value	0.953			

In the group-1, female patients were 28 (56%), and male were 22 (44%). In the group-2, female patients were 26

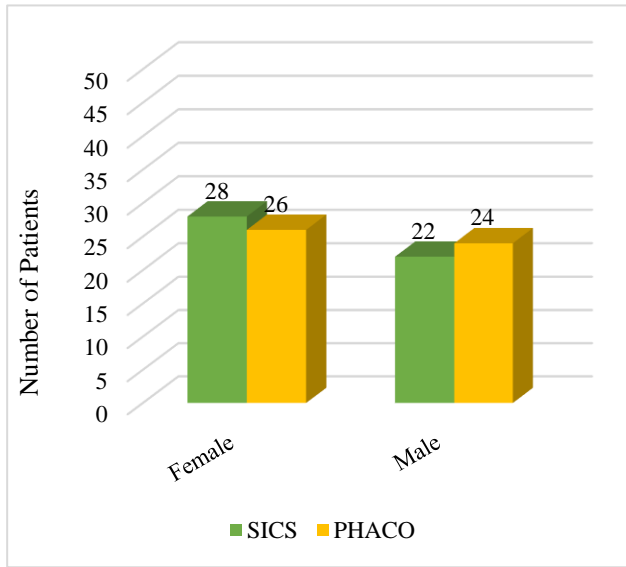(52%) and male were 24 (48%) with p=0.688. There was no significant difference in age distribution (Figure 1).

Figure 1: Gender distribution in study groups.

In the group 1, patients operated for cataract of left eye were 25 making 50%, patients operated for cataract of right eye were 25 (50%) of the total study subjects. In the group-2, patients operated for cataract of left eye were 6 (12%), patients operated for cataract of right eye were 44 (88%) with p=0.749 which is insignificant statistically (Figure 2).
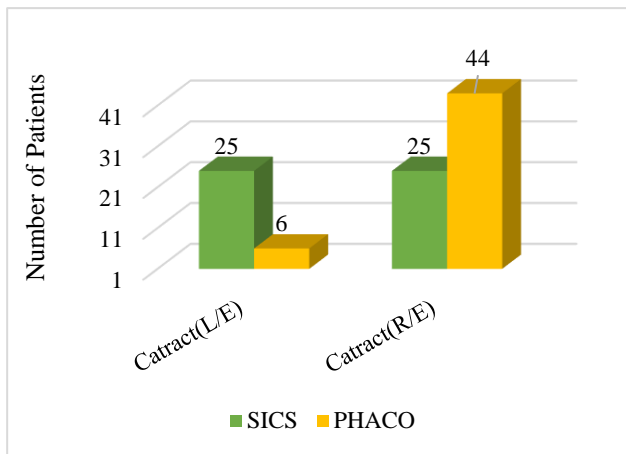

Figure 2: Distribution of groups according to laterality of eyes.

In the group 1, most patients had preop. BCVA of 6/36 being 15 (30 %) and those with BCVA of 6/36p, 6/12p and 6/12 were 1 each (2 %). In the group 2, patients having preop. BCVA of 6/60 and 6/36 were 13 each (26%) and those having F.C 4M=4/60, 6/36p, 6/12p and 6/12 were 1 each (2%) with p=0.125 which is statistically insignificant (Figure 3).

In group 1 macular thickness during preoperative period was 223.38±12.61 and in group-2 it was 224.14±12.69 with mean difference 0.76 and p=0.765 which is insignificant statistically (Figure 4).
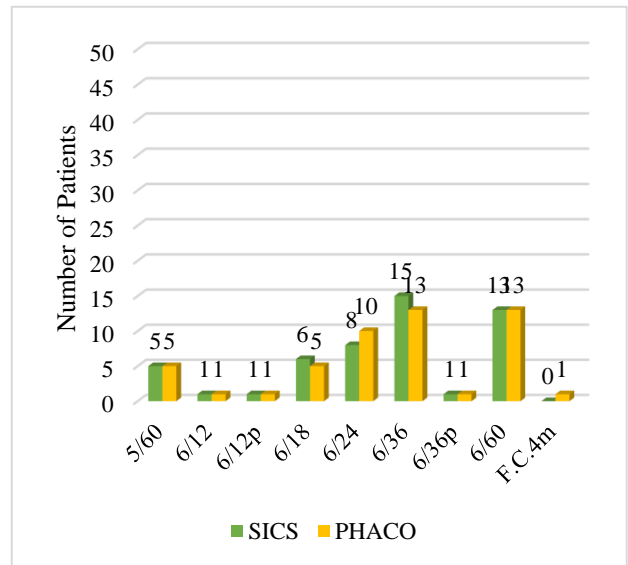

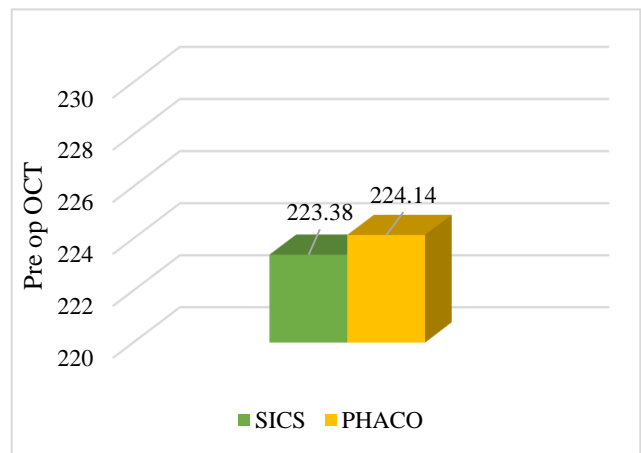**Figure 3: Pre-op best corrected visual acuity in both groups.**

Figure 4: Macular thickness during pre-operative period in both groups.

In group 1 on assessing post-operative observations, patients having no symptoms were 38 (76%) and those having CEH were 12 (24%). In the group 2, patients having no symptoms were 47 (94%) and those having CEH were 3 (6%) with p=0.012 which was statistically significant. Findings show that group 2 patients had less symptoms which was statistically proved. These findings show that visual outcome is very good in study subjects of both the groups but with better results in group 2 which is proved statistically in the present study (Table 2).

Table 2: Post-operative observations in both groups.

Post-op observation	SICS		PHACO	
	N	%	N	%
No symptoms	38	76	47	94
CEH	12	24	3	6
P value	0.012			

In group 1, visual acuity (mean with SD) during preoperative assessment was 0.258, on assessment during 12 weeks follow up it was 0.788 with mean difference -0.53 and p=0.000 which was highly significant statistically. In the group 2 patients, visual acuity (mean with SD) during preoperative assessment was 0.269, on assessment during 12 weeks follow up it was 0.844 with mean difference -0.58 and p= 0.000 which was highly significant statistically. These findings show that visual outcome was very good in study subjects of both the groups with better results in group 2 which is proved statistically in the present study (Table 3).

Table 3: Comparison of pre-op and post-op visual acuity (Mean±SD) at 12 weeks in both groups.

Pin hole	SICS	PHACO
Pre-op	0.258±0.09	0.269±0.11
12th week follow up	0.788±0.18	0.844±0.17
Mean difference	-0.53	-0.58
P value	0.000	0.000

In the group 1 patients, macular thickness (mean with SD) during 1 week follows up assessment was 238.28±12.29, on assessment during 12 weeks follow up it was 227.04±12.58 with mean difference 11.24000 and p value was 0.000 which is highly significant statistically. In the Group-2 patients, during 1 week follow up it was 231.90±12.42, on assessment during 12 weeks follow up it was 225.02±11.74 with mean difference 6.88000 and p value was 0.000 which was highly significant statistically. These findings show that macular thickness resolved in all the study subjects of both the groups with better results in group2 as mean difference is 4.36 in both the study groups which was proved statistically in present study and was nearly touching the baseline (Table 4).

Table 4: Comparison of macular thickness during 1 week and 12 weeks follow up post-operatively in both groups.

Variables	SICS	PHACO
Post-op 1 week follows up	238.28±12.29	231.90±12.42
Post-op 12 week follow up	227.04±12.58	225.02±11.74
Mean difference	11.24	6.88
P value	0.000	0.000

DISCUSSION

In group-1 patients up to ≥50 years of age was 11 (22%), 51-60 years 20 (40%), 61-70 years 15 (30%), 71-80 years 4, 8%. Mean age was 58.74±9.65. In the group-2, patients ≥50 years 12 (24%) and 51-60 years 15 (30%), 61-70 years 19 (38%), 71-80 years 4 (8%). Mean age was 58.62±9.65 with p=0.953 which is insignificant statistically.

In a study conducted by Garcia-Martin et al. in which thirty-five eyes from 35 subjects (20 men and 15 women, mean age 69.8 years, range, 48-80 years) were examined. Best-corrected visual acuity was 0.31±0.18 before cataract surgery and 0.84±0.19 after surgery. These findings are similar to the present study.[14]

In a study conducted by Gharbiya et al a total of 40 eyes of 40 uncomplicated cataract surgery patients (16 male and 24 female) were analysed. Mean age (±SD) was 62.1 (±5.8) years (range; 52-69 years). These findings are similar to the present study.[15]

In group 1 patients of female gender were 28 (56%), and male were 22 (44%). In the group-2 total female were 26 (52%) and male were 24 (48%) with p=0.688 which is insignificant statistically.

Study conducted by Abd El-Mawgoud et al that following cataract extraction there was a significant increase in postoperative mean choroidal thickness in vertical sub-macular scans (231.787±42.6 µm) and in horizontal sub macular scans (239.92±51.4 µm), it concluded that sub foveal choroidal thickness significantly increased at the 7th day postoperatively and reached a peak after 1 month of the surgery with a mean value of 232±76l µm at D1 (p<0.001), 237±78l µm at M1 (p<0.001), and 232±76 µm at M3 (p<0.001). The findings are supportive to the present study.[16]

Study conducted by Wang et al by using optical coherence tomography (OCT) findings showed significant differences of foveal thickness (p=0.02), foveal volume (p=0.02) and average retinal thickness (p=0.02) between two groups before operation. There are differences in macular thickness between pre-operation and 1 month after operation when compared with nasal outer macular ring thickness (p=0.022), foveal volume (p=0.005) and average retinal thickness (p=0.012) in ARC group. These findings are supportive to the present study.[17]

Pre-op visual acuity in the group 1 patients 5/60 was 5 (10 %), 6/12 was 1 (2 %), 6/12p was 1 (2%), 6/18 was 6 (12%), 6/24 was 8 (16%), 6/36 was 15 (30%), 6/36p was 1 (2%), 6/60 was 13 (26%). In the group-2 patients with VA 5/60 was 5 (10%), 6/12 was 1(2) %, 6/12p was 1 (2%), 6/18 was 5 (10%), 6/24 was 10 (20), 6/36 was 13 (26%), 6/36p was 1 (2%), 6/60 was 12 (24%) and FC

4M=4/60 was 1 (2%) with p=0.125 which was statistically nonsignificant in both groups.

In the group 1 during preoperative assessment mean value and SD of macular thickness of patients was 223.38±12.61. In group-2 patients was 224.14±12.69 with mean difference 0.76 and p=0.765 which was nonsignificant statistically in both groups.

In the group 1 patients with cortical and posterior subcapsular cataract was 6 (12%), nuclear sclerosis grade 2 cataract was 2 (4%), NS2 and Cort. cataract 14 (28%), NS2 and PSC 7 (14%), NS2, Cort. and PSC was 5 (10%), NS3 and PSC was 1 (2%), PSC was 15 (30%). In the group 2 patients Cort. and PSC was 6 (12%), NS2 cataract was 7 (14%), NS2 and Cort. cataract was 13 (26%), NS2 and PSC was 5 (10%), NS2, Cort. and PSC was 4 (8%), NS3 cataract was 1 (2%), NS3 and Cort. cataract 4 (8%), NS3, Cort. and PSC was 1 (2%) and PSC was 9 (18%) with p=0.227 which was statistically nonsignificant in both groups.

In the group 1 patients had no symptoms were 38 (76%), CEH were 12 (24%). In the group 2 patients had no symptoms were 47 (94%), CEH were 3 (6%) with p=0.012 which was statistically significant in both groups. Findings show that group-2 study subjects had less symptoms which was statistically proved. These findings show that visual outcome is very good in study subjects of both the groups but with better results in PHACO group which is proved statistically in the present study.

Comparison of mean value, mean difference and p value of visual acuity (pin hole vision) in the group 1 during preoperative assessment was 0.258, during 12 weeks follow up was 0.788 with mean difference -0.53 and p=0.000 which was highly significant statistically.

In the group 2 during preoperative assessment mean value, mean difference and p value of visual acuity was 0.269, during 12 weeks follow up was 0.844 with mean difference -0.58 and p=0.000 which was highly significant statistically. These findings show that visual outcome was very good in study subjects of both the groups with better results in group-2 which is proved statistically in the present study.

Comparison of mean value, SD, mean difference and p value of macular thickness in the group-1 patients during 1 week follow up assessment was 238.28±12.29, during 12 weeks follow up was 227.04±12.58 with mean difference 11.24000 and p=0.000 which is highly significant statistically. In the group-2 patients during 1 week follow up assessment of mean value, SD, mean difference and p value of macular thickness was 231.90±12.42, during 12 weeks follow up was 225.02±11.74 with mean difference 6.88000 and p=0.000 which was highly significant statistically. These findings show that macular thickness resolve in all the study

subjects of both the groups with better results in group-2 as mean difference is 4.36 in both the study groups which was proved statistically in the present study which was nearly touching the baseline.

Limitations

The present study was limited to the patients who were admitted in ophthalmology dept., Sri Guru Ram Das institute of medical sciences and research, Vallah, Sri Amritsar. Further study can be conducted on larger sample size.

CONCLUSION

It was observed that after cataract surgery, study subjects of both groups were having better vision and self-reported visual functioning. However, an increased post-operative local macular thickness was recorded during 1 week follow up while comparing macular thickness with the baseline in the both groups. These macular changes returned to nearly baseline values during the 12 weeks follow up visits. From this observation it is presumed that macular edema is caused by a subclinical inflammation triggered by the trauma of the operation and mediated by prostaglandins. Mechanical causes like intra operative trauma and alteration of the vitreous position after the removal and replacement of the lens could be contributory factors.

From above findings, it is concluded that visual outcome is very good in study subjects of both the groups but with better results in PHACO group which was proved statistically in the present study. These findings also show that a mild increase in macular thickness was noted which however, did not impact visual acuity and resolved in all the study subjects of both the groups, with better results in PHACO group and was proved statistically in the present study.

REFERENCES

1. Bowling B. Kanski's clinical ophthalmology: A systematic approach. 8th ed. London, England: WB Saunders. 2015;630-1.
2. Byrnes GA, Antoszyk AN, Mazur DO, Kao TC, Miller SA. photic maculopathy after extracapsular cataract surgery-a prospective study. Ophthalmology. 1992;99(5):731-7.
3. Ichhpujani P. Expert Techniques in Ophthalmic Surgery 1st ed. Jaypee Brothers Medical Publishers. 2015;5.
4. Mentes J, Erakgun T, Afrashi F, Kerci G. incidence of cystoid macular edema after uncomplicated

phacoemulsification. Ophthalmologica. 2003;217(6):408-12.

5. Khanna R, Pujari S, Sangwan V. Cataract surgery in developing countries. Curr Opin Ophthalmol. 2011;22(1):10-4.

6. Gogate PM, Kulkarni SR, Krishnaiah S, Deshpande RD, Joshi Sa DMD. safety and efficacy of phacoemulsification compared with manual small incision cataract surgery by a randomized control clinic trail: six-week result. Ophthalmology. 2005;112:869-74.

7. Samuel Boyd R, Brancato BS. Optical coherence tomography-Atlas and text 1st ed; Jaypee-Highlights Medical Publishers. 2009;1-11.

8. Hee MR, Puliafito CA. Wong C. Quantitative assessment of macular edema with OCT. Arch Ophthalmol. 1998;105:360-70.

9. Boyd S. Optical coherence tomography-Atlas and text, 1st Ed, Published by Jaypee-Highlights Medical Publishers, Inc. 2000;1-11.

10. Danis RP, Fisher MR, Lambert E, Goulding A, Wu D, Lee LY. Results and repeatability of retinal thickness measurement from certificate submissions. Arch Ophthalmol. 2008;126(1):45-50.

11. Garg A, Alio JL. Surgical. Tech Ophthalmol 1st ed. 2010:65-75, 205-210.

12. Yanoff M, Duker's J. Ophthalmology, 5th ed. Elsevier Publications. 2019;626-31.

13. Miyake K, Ibaraki N. prostaglandins and cystoid macular edema. Surv Ophthalmol. 2002;47(1):S203-18.

14. Garcia-Martin E, Fernandez J, Gil-Arribas L, Polo V, Larrosa JM, Otin S et al. Effect of cataract surgery on optical coherence tomography measurements and repeatability in patients with non-insulin-dependent diabetes mellitus. Invest Ophthalmol Vis Sci. 2013;54(8):5303-12.

15. Gharbiya M, Cruciani F, Cuozzo G, Parisi F, Russo P, Abdolrahimzadeh S. Macular thickness changes evaluated with spectral domain optical coherence tomography after uncomplicated phacoemulsification. Eye (Lond). 2013;27(5):605-11.

16. Abd El-Mawgoud SM, Arfeen SAS, El-Gendy NS, Fathy AM. National Eye Center, Cairo, Egypt, Delta. J Ophthalmol Year. 2018;19(2):106-10.

17. Wang Y, Du J, Yang M, Xu Y, Guan H, Wu J. Distinct macular thickness changes after femtosecond laser-assisted cataract surgery of age-related cataract and myopia with cataract. Sci Rep. 2018;8(1):3279.