

Comparative Study Endothelial Cells Before and After Cataract Surgery

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Abstract

AIMS

Prospective comparison of endothelial cell study (density and morphology) and central corneal thickness before and after small incision cataract surgery.

Prospective comparison of endothelial cell study (density and morphology) and central corneal thickness before and after Phacoemulsification.

MATERIALS AND METHODS

Settings and design

The present study is prospective randomized study to determine which technique of cataract surgery that is SICS vs phaco maintains corneal thickness and endothelial cells closest to normal physiological state.

Sample size: 154 Patients undergoing SICS and Phacoemulsification surgery.

RESULTS:

Pre and postoperative 6 week mean difference parameters of two group that is the mean difference of CD in Group 1 (SICS) and group 2 (phaco) was 231.43 ± 56.28 and 225.96 ± 61.34 respectively and mean difference of CCT in Group 1 and group 2 was 3.53 ± 10.60 and 1.89 ± 5.38 respectively. ($p > 0.05$)

CONCLUSION:

There is no statistically significant difference found in between SICS and phaco group which suggests the function and morphology of endothelial cells was not affected by both the surgeries. Even it is not affected by pupillary dilatation, grade of cataract and duration of surgery.

Keywords: ENDOTHELIAL CELLS PHACO SICS

INTRODUCTION

Cataract is a leading cause of preventable blindness and is responsible for 47% blindness worldwide.¹ It contributes 62.6% of preventable blindness in India.²

Surgical intervention is the treatment of choice. Phacoemulsification and small incision cataract surgery with intraocular lens implantation are the common procedures. Both procedures are relatively safe ophthalmic procedures with few complications like vitreous loss, Posterior capsular rupture and post-

operative complications Posterior capsule opacification, retinal detachment and Cystoid macular oedema.^{3,4}

Corneal endothelial cell loss remains a well known and undesirable complication of cataract surgery that can impact post-op visual recovery⁵ as endothelium morphological and functional integrity helps to maintain corneal transparency. There is no regeneration of endothelial cells.⁵ So endothelial cells

loss during cataract surgery is not recoverable. The loss is compensated by increase in cell size and increase cell thickness. Corneal decompensation occurs after >75% of the adult age cells loss that is when endothelial cell count becomes <500cells/mm³.⁵ Advances in surgical technique, implementation of newer technologies, viscoelastics can reduce the endothelial loss.⁵

Phacoemulsification and small incision cataract surgery are commonly performed cataract surgeries but there is paucity of data on effect of these surgeries on corneal endothelium (morphological and functional).⁶ So the study was performed to compare the postoperative endothelial cell loss and change in endothelial morphology over a short period of time between these two commonly performed cataract techniques. The response and effect of stress and trauma of cataract surgery on endothelial cell could not have been so well documented if there is no advent of specular microscopy.⁶

Specular microscopy is a standard method to determine corneal endothelial density and morphology in vivo because it allows a qualitative and quantitative study of corneal endothelial cells.⁷

The present study was done to determine as to which technique (phacoemulsification vs small incision cataract surgery) maintains corneal thickness and endothelial cell function near to normal physiological state.

AIMS AND OBJECTIVES:

- Prospective comparison of endothelial cell study (density and morphology) and central corneal thickness before and after Small incision cataract surgery.
- Prospective comparison of endothelial cell study (density and morphology) and central corneal thickness before and after Phacoemulsification.

MATERIALS AND METHODOLOGY:

Study design:

The present study is prospective randomized study to determine which technique of cataract surgery that is SICS vs phaco maintains corneal thickness and endothelial cells closest to normal physiological state.

Study period:

The present study period was August 2018 to April 2020.

Study population:

The study population was patients undergoing SICS and Phacoemulsification surgery.

Study area:

The study was conducted undergoing SICS and Phacoemulsification surgery in Mahatme Eye Hospital, Somalwada Nagpur.

Sample size:

A sample size of 154 Patients undergoing SICS and Phacoemulsification surgery were enrolled for the study.

Inclusion Criteria:

- Patients between 40 to 80 years of age willing for cataract surgery by Small incision cataract surgery or Phacoemulsification.
- Either sex Senile cataract upto grade 3

Exclusion Criteria:

- Patients who had not given consent
- Patients with grade 4 or mature or hypermature or subluxated cataract.
- Patients with preoperative endothelial cell count less than 2000cells/mm³
- Patients with complicated cataract
- Patients with raised Intraocular pressure. Patients with pre-existing corneal diseases. One eyed patients.
- History of ocular surgery in concerned eye.
- Patients with past history of ocular trauma in concerned eye.
- Patients with intraoperative complication during cataract surgery.

Ethical consideration:

The study was approved by the Ethical Committee of the institute.

METHODOLOGY OF STUDY:

- Informed consent was taken from the patients who fulfill the inclusion criteria.

- Detail ocular history and if any significant systemic history of CVS,RS, GIT,CNS was taken
- Patients fitting in inclusion criteria by excluding patients of exclusion criteria.
- Measurement of uncorrected visual acuity (UCVA), with pin hole visual acuity (PHVA) and best corrected visual acuity (BCVA) for distance and near using LogMAR chart was done both pre and post operatively.
- Detail slit lamp ophthalmological examination was done including grading of cataract upto ns 3 depending on nuclear sclerosis.
- Dilated fundus examination using +90D and +20D was done.
- Preoperative endothelial cell study and central corneal thickness by using noncontact specular microscopy CEM 530 was taken.
- Post operative medicines given to patients and discharged.
- Patients called for follow up and on follow up after detail examination of operated eye, specular images were taken.
- Main follow ups – postoperative day 1 and week 6

Parameters studied:

On specular microscopy of analysed area includes:

- CCT = central corneal thickness (CCT), CD = Endothelial cell density ,
- Polymorphism = Hexagonality (%) for variation in the cell shape (polymorphism).
- COV= Coefficient of variation.

Operative procedure:

- The pupil was dilated using tropicamide 0.8% with phenylephrine hydrochloride 5% solution, and flurbiprofen 0.03% eye drops one hour prior to surgery for every 15 minutes.

Anaesthesia: Peribulbar Anaesthesia

- 5 ml mixture of lignocaine solution 2% (with adrenaline 1 in 100000 and without adrenaline for hypertensive and diabetic individuals) with hyaluronidase 5 IU/ml with Bupivacaine solution

0.5% is used.

Procedure for Small incision cataract surgery:

- After cleaning with betadine solution draping done under all aseptic precautions.
- Superior rectus bridle suture passed.
- A fornix based conjunctival flap was made at the superior limbus extending from 10-1 o' clock, and bleeders was cauterized by using diathermy cautery.
- Approximately 6.0 mm incision was made on the sclera 1.5 mm away from the superior limbus.
- A corneoscleral tunnel was made by using 1.5 tunnel crescent knife.
- A side port was made between 7-9 o'clock. Hydroxypropyl methylcellulose (HPMC) 2% was injected to fill the anterior chamber.
- Staining of anterior capsule done by using trypan blue; dye is washed with saline and viscoelastic substance is injected.
- A 26 gauge bent capsulotomy needle was used to create a continuous curvilinear capsulorhexis (CCC).
- An entry was made through the tunnel using 3.2 mm keratome. The tunnel was then extended using an extension blade.
- Hydrodissection was performed using balanced salt solution.
- The anterior chamber was refilled with viscoelastic (HPMC 2%) and the nucleus rotated and tumbled into anterior chamber with dialer.
- The viscoelastic was again injected below to maintain the anterior chamber as well as above nucleus to protect endothelium.
- The nucleus was then delivered using visco-expression.
- The remaining cortical matter was removed with simcoe's irrigation and aspiration cannula.
- After which a polymethylmethacrylate posterior chamber IOL was placed in the capsular bag.
- Side port wound was closed by hydrating the stroma.
- A subconjunctival injection (0.3 ml) of 10 mg

gentamicin and 2 mg dexamethasone was given.

- A drop of topical antibiotic steroid solution was administered and eye was patched. The procedure was carried out with meticulous aseptic precautions.

Procedure for Phacoemulsification:

- After cleaning with betadine solution; draping done under all aseptic precautions.
- A superior clear corneal incision of 2.8 mm and two side port entries are made at 3 o'clock and 9 o'clock followed by staining of anterior capsule by trypan blue dye followed by injection of viscoelastic substance (2% hydroxypropylmethylcellulose) to maintain the anterior chamber.
- Continuous curvilinear capsulorhexis (CCC) of 5-6 mm was done by 26 gauge bent capsulotomy needle.
- Hydrodissection were performed using balanced salt solution.
- The viscoelastic was then injected and the nucleus stabilised with chopper.
- A divide and conquer technique was done using phacoemulsification inside the capsular bag. Cortex was removed by irrigation and aspiration. Balanced salt solution was used for irrigation.
- A foldable acrylic IOL was then implanted into capsular bag. Wound was closed by hydrating the stroma.
- A subconjunctival injection (0.3 ml) of 10 mg gentamicin and 2 mg dexamethasone was given.
- A drop of topical antibiotic steroid solution was administered and eye was patched. The procedure was carried out with meticulous aseptic precautions.

Post-operative care

- The post-operative care was given with course of topical antibiotics, topical steroid in tapering doses for 6 weeks to all the patients.

All patients were followed after 1st day and 6th week.

- At each visit preliminary examination like visual acuity, slit lamp examination, intraocular pressure and specular microscopy was done.

Follow up: Postoperative day 1 and on 6th week respectively.

STATISTICAL ANALYSIS OF RESULTS:

The data was filled in excel sheet and the results were described as frequency and proportion. Results are presented as mean, standard deviation and range values for continuous data, number and percentages for categorical data. Intergroup comparisons are done by unpaired t test and intra group comparisons by paired t test. p value of 0.05 or less was considered for statistically significance. The comparison was done by chi-square test with significance at $p < 0.05$.

RESULTS:

Table 1 shows mean pre-operative CD in Group 1(SICS) and Group 2 (Phaco) was 2589.98 ± 166.71 and 2617.17 ± 192.40 respectively and mean CCT in group 1 and 2 was 521.62 ± 19.11 and 526.14 ± 25.18 respectively. This difference in pre-operative CD among patients in two groups was statistically not significant. ($P > 0.05$). Similarly, the difference in pre-operative COV, Hex and CCT among patients in two groups was statistically not significant. ($P > 0.05$)

Table 2 shows comparison of Postoperative day 1 parameters of two groups. The mean post-operative day 1 CD in Group 1(SICS) and Group 2 (Phaco) was 2488.74 ± 167.59 and 2516.90 ± 196.35 respectively and mean

CCT in group 1 and 2 was 582.92 ± 30.12 and 581.64 ± 37.73 respectively. This comparison in post-operative day 1 CD among patients in two groups was statistically not significant. ($P > 0.05$). Similarly, the difference in post-operative day 1 COV, Hex and CCT among patients in two groups was statistically not significant. ($P > 0.05$)

Table 3 shows comparison of Postoperative week 6 parameters of two groups. The mean post-operative week 6 CD in Group 1 (SICS) and Group 2 (Phaco) was 2358.54 ± 170.86 and 2391.21 ± 201.69 respectively and mean CCT in group 1 and 2 was 518.08 ± 21.10 and 524.25 ± 25.66 respectively. This comparison in post-operative week 6 CD among patients in two groups was statistically not significant. ($P > 0.05$)

Table 4 shows comparison of pre and postoperative day 1 mean difference parameters of two groups that is mean difference of CD in group 1 and group 2 was 101.23 ± 24.92 and 100.27 ± 35.72 and mean difference of CCT in Group 1 and group 2 was 61.30 ± 13.71 and 55.5 ± 20.53 respectively. The mean difference of CCT in

Phaco group was less compared to SICS group with statistically significant difference. ($P < 0.05$) The pre and postoperative day 1 mean difference of COV, Hex and CD among patients in two groups was statistically not significant. ($P > 0.05$).

Table 5 shows comparison of pre and postoperative 6 week mean difference parameters of two group that is the mean difference of CD in Group 1 and group 2 was 231.43 ± 56.28 and 225.96 ± 61.34 respectively and mean difference of CCT in Group 1 and group 2 was 3.53 ± 10.60 and 1.89 ± 5.38 respectively. The mean difference of COV in Phaco group was more compared to SICS group with statistically significant difference. ($P < 0.05$). The pre and postoperative 6 week mean difference of CD, Hex and CCT among patients in two groups was statistically not significant. ($P > 0.05$)

DISCUSSION:

Comparison of corneal thickness and endothelial cells before and after SICS:

The mean pre-operative, post operative day 1- and 6-week CD in SICS group was 2589.98 ± 166.71 , 2488.74 ± 167.59 and 2358.54 ± 170.86

respectively. There was decrease of CD in SICS group at post operative day 1 by 3.9% from baseline and 8.9% after 6 weeks postoperative from baseline with no statistically significant difference. (> 0.05) (Table no.4-8). The mean pre- operative, post operative 1 day and 6-week CCT in SICS group was 521.62 ± 19.11 , 582.92 ± 30.12 and 518.08 ± 21.10 respectively. There was increase of CCT in SICS group at post operative day 1 by 11.75% from baseline and return back to baseline after 6 weeks postoperative from with no statistical significant difference (> 0.05). (Table no.4-8)

In study by Sunil Ganekal *et al*⁸ where there was a decrease in cell density of 76.12 cells/mm (3.27%) in SICS group. This difference in mean endothelial cell density at 1 week and 6 weeks was statistically significant.

A study by Muralikrishnan R *et al*⁹ comparing phacoemulsification and conventional ECCE reported a 10% reduction in endothelial cells in SICS group.

Another study by Bourne RR *et al*¹⁰ evaluated endothelial cell damage after phacoemulsification and planned ECCE with different capsulotomy

Comparison of corneal thickness and endothelial cells before and after Phaco:

The mean pre-operative, post operative day 1 and 6 week CD in Phaco group was 2617.17 ± 192.40 , 2516.90 ± 197.58 and 2391.21 ± 201.69

respectively. There was decrease of CD in phaco group at post operative day 1 by 3.8% from baseline and 8.6% after 6 week postoperative from baseline with no statistical significant difference. (> 0.05) (Table no.4-8)

The mean pre-operative, post operative 1 day and 6 week CCT in Phaco group was 526.14 ± 25.18 , 581.64 ± 37.73 and 524.25 ± 25.66 respectively. There was increase of CCT in phaco group at post operative day 1 by 10.54% from baseline and return back to baseline after 6 week postoperative from with no statistical significant difference. (> 0.05) (Table no.4-8)

Bourne RR *et al*¹⁰ evaluated endothelial cell damage after phacoemulsification. The mean cell loss was 11.8% in the phacoemulsification group which was similar to present study.

In study by Shrikant Deshpande *et al*¹¹ a statistically significant increase ($p < 0.05$) in central corneal thickness on day 7th and 30th. Hence it shows that there was some endothelial cell loss leading to change in corneal thickness but not to the extent to cause visual impairment post operatively.

Endothelial alteration is considered an important parameter of surgical trauma and essential for estimating the safety of the surgical technique. After cataract surgery, endothelial cell density decreases at a greater rate than in healthy, un-operated corneas. There is a wide variation in endothelial cell loss between the various studies even when the mode of surgery is same (e.g., SICS). This is due to various factors including, different inclusion and exclusion criteria, different grades of cataract, different methods of nucleus delivery in SICS, different types of irrigating solution and viscoelastics.¹¹

Comparison of corneal thickness and endothelial cells among both groups:

The difference in pre-operative CD, COV, Hex and CCT among patients in two groups was statistically not significant. ($P > 0.05$) (Table no.4-8)

The mean difference in pre-operative and post operative day 1 CD in Group 1 (SICS) and Group 2 (Phaco) was

101.23 ± 24.92 and 100.27 ± 35.72 respectively which was statistically not significant. (P>0.05)(Table no.7)

The mean difference in pre-operative and post operative day 1 CCT in Group 1(SICS) and Group 2 (Phaco) was 61.30 ± 13.71 and 55.5 ± 20.53 respectively which is statistically significant. (P<0.05) (Table no.7)

The mean difference in pre-operative and post operative week 6 CD in Group 1(SICS) and Group 2 (Phaco) was 231.43 ± 56.28 and 225.96 ± 61.34 respectively and CCT was 3.53±10.60 and 1.89 ±5.38 respectively which was statistically not significant. (P>0.05) (Table no.8)

The pre and postoperative week 6 mean difference COV in Group Phaco and SICS group was 1.63 ± 1.90 and 0.74 ± 1.28 respectively. The mean difference of COV in Phaco group was more compared to SICS group with statistically significant difference. (P<0.05) (Table no.8).

The pre and postoperative 6 week mean difference of CD, Hex and CCT among patients in two groups was statistically not significant. (P>0.05)(Table no.8)

The findings of present study was in accordance to study by Sunil Ganekal et al⁸ the central corneal thickness, coefficient of variation, and standard deviation were maintained in both groups indicating that the function and morphology of endothelial cells, was not affected despite a reduction in cell number in MSICS compared to phacoemulsification.

Cheng H and associates¹² also found a significant linear correlation between increase in corneal thickness in the immediate postoperative period and percentage of cell loss, one and six months after surgery.

Bjorn Lundberg and associates¹³ through their study concluded that the central corneal swelling at postoperative day 1 is strongly correlated with the central corneal endothelial cell loss at 3 months and that the difference in pachymetry at postoperative day 1 is a useful way to assess the effects on the corneal endothelium exerted by the phacoemulsification procedure.

Mencucci R and associates¹⁴ concluded that there was no difference in corneal thickness, corneal endothelial cell loss or endothelial morphology between phaco and MICS groups at the end of 1 and 3 month.

Michaeli A and colleagues¹⁵ found that corneal thickness increased significantly in all measurements post-op and returned to baseline by 3 months and there was no difference in the pachymetry change between the two study groups in phaco.

CONCLUSION:

There is no statistically significant difference found in between SICS and phaco group which suggests the function and morphology of endothelial cells was not affected by both the surgeries.

RECOMMENDATIONS:

The future randomized studies in a larger sample with longer duration of follow up techniques.

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TABLE 1 Preoperative parameters of two groups

Preoperative (Pre)	Group 1	Group 2	P value
	(SICS)	(Phaco)	
Pre CD	2589.98 ± 166.71	2617.17 ± 192.40	0.69
Pre COV	29.30 ± 2.61	30.57 ± 3.27	0.71
Pre Hex	66.39 ± 3.37	66.60 ± 4.25	0.89
Pre CCT	521.62 ± 19.11	526.14 ± 25.18	0.61

TABLE 2 Comparison of Postoperative day 1 parameters of two groups

Postop Day 1	Group 1 (SICS)	Group 2 (Phaco)	P value
Post op Day 1 CD	2488.74 ± 167.59	2516.90 ± 197.58	0.49
Post op Day 1 COV	28.67 ± 2.67	30.39 ± 3.68	0.73
Post op Day 1 Hex	65.28 ± 4.90	65.44 ± 4.28	0.82
Post op Day 1 CCT	582.92 ± 30.12	581.64 ± 37.73	0.76

TABLE 3 Comparison of Postoperative week 6 parameters of two groups

Postop week 6	Group 1 (SICS)	Group 2 (Phaco)	P value
Post op Week 6 CD	2358.54 ± 170.86	2391.21 ± 201.69	0.56

Post op Week 6 COV	30.04 ± 2.69	32.20 ± 3.52	0.81
Post op Week 6 Hex	62.90 ± 3.35	63.07 ± 4.55	0.69
Post op Week 6 CCT	518.08 ± 21.10	524.25 ± 25.66	0.71

TABLE 4 Comparison of Pre and Postoperative day 1 mean difference among two groups

Pre & Postop day 1	Group 1 (SICS)	Group 2 (Phaco)	P value
Pre-1cd	101.23 ± 24.92	100.27 ± 35.72	0.84
Pre-1cov	0.63 ± 1.32	0.18 ± 2.81	0.21
Pre-1hex	1.11 ± 3.88	1.16 ± 1.44	0.45
Pre-1cct	61.30 ± 13.71	55.5 ± 20.53	0.001

Table 5: Comparison of Pre and Postoperative 6th week mean difference among two groups

Pre & Postop 6 wks	Group 1 (SICS)	Group 2 (Phaco)	P value
Pre-6cd	231.43 ± 56.28	225.96 ± 61.34	0.55
Pre-6cov	0.74 ± 1.28	1.63 ± 1.90	0.001
Pre-6hex	3.49 ± 2.34	3.53 ± 3.10	0.97
Pre-6cct	3.53 ± 10.60	1.89 ± 5.38	0.66