**Original article:**

**Study of corneal endothelial cells after cataract surgery**

**1Dr. Ravi Chauhan, 2Dr. Jayshree Ekhar, 3 Dr. Amit Rajendra Agrawal\* ,**

**4Dr. Aishwarya Rameshrao Kailuke**

1Professor and Head of Department , 2Assistant Professor, 3, 4 Junior Resident

Department of Ophthalmology, Indira Gandhi Government Medical College, Nagpur, Maharashtra India

Corresponding author \*

**ABSTRACT   
INTRODUCTION:** Senile cataract has been documented to be the most significant cause of bilateral blindness in India. Cataract Extraction constitutes the largest workload in ophthalmic units in India. Cataract is responsible for 62.4% of blindness in India and the prevalence of blindness due to cataract is 5.3% [1]. Such a high prevalence of cataract is due to absence of effective eye health care delivery system , COVID outbreaks resulting in cessation of non-emergency surgeries and relatively poor surgical care.

**METHODOLOGY:** Detailed history including demographics, ocular disease, past medical and surgical history, drug history and personal history and examination was done for all the study participants. An informed written consent was taken from all the patients. The need for the investigations and the procedure to be done was explained to all in detail. The patients have given wilful consent to be a part of the study.

**RESULTS:** The comparison between both groups postoperatively, showed statistically insignificant alteration in cell density of endothelial cells in cornea post operatively. (p value 0.4). The comparison between both groups postoperatively, showed statistically insignificant alteration in Central Corneal Thickness of cornea post operatively. (p value 0.39).

**CONCLUSION:** The results in our study show that manual SICS is as safe for the corneal endothelium as phacoemulsification, is almost as effective, and is much more economical. These factors indicate that SICS can be an alternative to phacoemulsification in areas in which surgeons proficient in phacoemulsification and phaco machines are not available.

**KEYWORDS**: corneal endothelial cells , cataract surgery

**INTRODUCTION**

Senile cataract has been documented to be the most significant cause of bilateral blindness in India. Cataract Extraction constitutes the largest workload in ophthalmic units in India. Cataract is responsible for 62.4% of blindness in India and the prevalence of blindness due to cataract is 5.3% [1]. Such a high prevalence of cataract is due to absence of effective eye health care delivery system , COVID outbreaks resulting in cessation of non-emergency surgeries and relatively poor surgical care. Today’s cataract surgery focuses on rapid visual rehabilitation and minimum surgically induced astigmatism.[2] As a cataract surgeon, we want to see a happy patient on first post operative day with a clear cornea, quiet eye and a centred IOL.

Corneal endothelial morphology and central corneal thickness (CCT) are important parameters for evaluating the cornea. Protection of Corneal Endothelial cells are critical for achieving good visual outcome during cataract surgery. The normal density of corneal endothelial cells in adults is approximately 2000-3000 cells/mm2. Corneal endothelial cells are largely hexagonal cells, responsible for maintaining the desiccation of the stroma by actively removing water and thus play a pivotal role in maintaining the clarity of the cornea [3].

The corneal endothelium has limited capacity to regenerate so when endothelial cells are damaged due to surgical trauma, diseases or aging, the adjacent cells enlarge to maintain the continuity of the layer. This leads to significant cell enlargement, change in the cell density and morphology. Endothelial cell density and function can be assessed clinically using specular microscopy and pachymetry. The clinical specular microscopes are all based on the laboratory microscope design by Maurice to provide a high magnification view of specular reflected light from the Corneal endothelium. The specular reflex occurs at a regular, smooth surfaced interface of two refractive indices with light from the subject having an angle of incidence equal to the angle of reflection to the observer. The endothelial cells can be imaged because the refractive index of the endothelial cells is greater than the 1.336 value of the aqueous humor, thus reflecting 0.022% of the projected light. [4]

MSICS is a cost - effective technique to phacoemulsification which gives comparable results. It is particularly useful in these dense cataracts which are seen more frequently in countries like India.[5] There is concern that manual SICS may be more harmful to the endothelium than phacoemulsification because most manipulation is performed manually in the anterior chamber (AC); whereas in phacoemulsification, manoeuvring is performed in the capsular bag, relatively far from endothelium. [6]

Some ophthalmologists believe that the difference in endothelial cell loss in small incision cataract surgery (SICS) and phacoemulsification is not significant where as others have reported in their studies that there is very less cell loss in phacoemulsification. [7]  Hence, this study is an attempt to study and compare the endothelial cell loss and other parameters in these two commonly performed cataract extraction procedures.

**MATERIALS AND METHODS**

**Study design and study area**

Study group included 174 patients aged above 45 years and both

gender operated in Indira Gandhi Government Medical College and

Hospital, Nagpur from August 2020 to August 2023 for cataract surgery.

**STUDY DESIGN**

Prospective Randomized Follow - Up study

**SAMPLE SIZE**

We analysed 174 patients (147 eyes for small incision cataract surgery and 27 eyes for phacoemulsification)

**INCLUSION CRITERIA**

* Patients aged more than 45 years attending Ophthalmology OPD and diagnosed with cataract at our institute.

**EXCLUSION CRITERIA**

* History of Chronic Ocular Inflammation.
* History of prior Intra-Ocular Surgery in the eye to be operated now.
* Patients with Corneal Opacity or pre-existing corneal pathology.
* Patients having Traumatic cataract or history of ocular trauma.
* Complicated Cataract.
* Patients having co-existing Glaucoma, Uveitis, Acute Infection, Pterygium, Retinal Pathology, Pseudoexfoliation along with Cataract.
* Pre operative Endothelial Cell Count of less than 1500 cells/mm2.
* Patients who have undergone C3R or LASIK previously or Contact Lens wear.

**DATA COLLECTION AND PRE-OPERATIVE WORK UP OF PATIENTS: -**

Detailed history including demographics, ocular disease, past medical and surgical history, drug history and personal history and examination was done for all the study participants. An informed written consent was taken from all the patients. The need for the investigations and the procedure to be done was explained to all in detail. The patients have given wilful consent to be a part of the study.

**PRE-OPERATIVE EVALUATION:**

1) BCVA – Best Corrected Visual acuity was checked in all patients using Snellen’s chart (with and without pinhole).

2) Near vision with Times New Roman Chart

3) SLIT LAMP BIOMICROSCOPY: for detailed anterior segment evaluation

4) INTRAOCULAR PRESSURE – Using Goldmann’s Applanation Tonometer.

5) Direct and Indirect Ophthalmoscopy was done and slit-lamp biomicroscopic examination was done using 90D for detailed posterior segment evaluation.

6) B-SCAN: in cases of mature cataract for posterior segment evaluation.

7) Nasolacrimal Duct Syringing, Routine Preoperative systemic Investigations (ECG, Fasting and Postprandial Blood Sugar Levels, Physician Fitness) done.

8) Lens Opacities Classification System III (LOCS III) was used to grade the cataract.

9) Specular Microscopy was done using Konan Non-Contact Specular Microscope X (NSP – 9900). It was done pre – operatively and at 1-month post-operative follow up. Three readings were taken and an average of three readings was finally taken as the result. The measurements were done by a single evaluator to measure central corneal Endothelial Cell Density, Percentage of Hexagonal cells and Central Corneal Thickness (in micrometres).

10) All 174 patients were operated at our institute by either Manual Small Incision Cataract Surgery (MSICS) or Phacoemulsification with PCIOL Implantation. All Surgeries were done by a single surgeon.

11) At 1 month post- operative follow up visit of the patient, best corrected visual acuity was checked and any post- operative complications were also noted by doing slit lamp examination and fundus examination.

**INTRA – OPERATIVE PROCEDURE: -**

All patients put on topical antibiotic drops 1 day prior to surgery and patched the night before surgery. Tablet Acetazolamide 250 mg with 5 mL Potassium Chloride syrup given on the night before surgery and on morning of surgery. Patients dilated with mydriatic drops (Tropicamide and Phenylephrine) and Flurbiprofen sodium drops.

All surgeries will be performed at our institute under peribulbar block with 5 ml of 2% Lignocaine with or without 1:100000 adrenaline and 5 ml of 0.5% bupivacaine with 150 units/ml of hyaluronidase, povidone-iodine 5% will be instilled into the conjunctival sac. Under All Aseptic Precautions & Peri Bulbar Block, Painting and Draping done. Universal Wire speculum applied. Thorough Conjunctival Wash given.

A] **Manual Small Incision Cataract Surgery: -**

1) Superior Rectus [Bridle] suture passed to fix eye.2) Fornix base conjunctival flap made,3) Partial thickness scleral incision of 6 – 8 mm will be made with bard parker knife with 15 no. blade superiorly and partial thickness sclerocorneal tunnel will be constructed with crescent. 4)Side port entry of about 1.5 mm will be made by side port entry blade, 5) Trypan blue dye (0.1%) will be injected intracamerally to stain the anterior capsule. . 6) Injection of viscoelastic hydroxypropyl methylcellulose after entry in anterior chamber 7) Continuous curvilinear capsulorrhexis (CCC) using the needle cystitome .8) Anterior Chamber entry and extension is done by making internal corneal incision by 3.2 mm keratome. 9) Gentle, thorough hydrodissection will be performed to separate cortex from nucleus. Prolapse of nucleus out of the capsular bag into the anterior chamber done by rotating the nucleus with Sinskey’s hook. Nucleus will be delivered by Viscoexpression technique. 10)Irrigation and aspiration will be done with Simcoe's two-way irrigation and aspiration cannula.11) Rigid, single piece, biconvex, PolyMethyl Metha Acrylate (PMMA) posterior chamber intraocular lens (IOLs) implanted in bag using Kelman McPherson forceps and dialed into position using Sinskey’s Hook. 12) Removal of Viscoelastic substance and wound closure done. 13)Subconjunctival gentamycin and dexamethasone was given. Patch and bandaging was done.

B] **Phacoemulsification:-**

1)Sideport made with Micro VitreoRetinal (MVR) blade. 2)Inj.Rhexid injected in Anterior Chamber (AC). AC wash given. AC formed with viscoelastic substance. 3)Continuous Curvilinear Capsulorrhexis done with cystitome. 4)Hydrodissection done. 5)Main Incision made with 2.8mm keratome blade. 6) Phacoprobe inserted through main incision and Sinskey’s Hook inserted through side port. 7)Nucleus broken into 2 pieces and then into multiple pieces and aspirated. 8)Remaining Cortical matter aspirated with irrigation and aspiration cannula. AC formed with viscoelastic. 9) Foldable PCIOL implanted with Kelman- Mcpherson forceps and dialed into PC bag. 10)AC wash given. 11) Subconjunctival Dexamethasone and Gentamycin inj. Given. Pad and Bandaging done.

Post – Operatively, patients put on topical Moxifloxacin + Ketorolac tromethamine and Prednisolone 1% tapered over 4-6 weeks depending upon the post-operative inflammation. Homatropine hydrochloride 1% eyedrops added twice daily for 1 week.

**DATA ANALYSIS: -**

Data was analysed using SPSS software 16 version, quantitative data are presented as Mean ± Standard Deviation (SD) and qualitative data are presented as frequencies.

Parametric tests (Independent t -test) were used for statistical analysis of quantitative variables and to compare mean differences within groups and paired t – test was used to compare mean differences between 2 groups.

P value of <0.05 was considered statistically significant

**ETHICS**

Institute Ethical committee approval was taken prior to the study. Consent of patient taken only after giving full information about study. Patient was assured his/ her reports were kept confidential.

**RESULTS**

The demographic data of the patients included in the study was analysed. There were 87 (50%) males and 87 (50%) females out of 174 patients.

67 (38.50%) patients were from 51- 60 years age group followed by 54 (31.03%) patients in 61 – 70 years age group.

Out of the 174 patients included in the study, 147 (84%) patients underwent MSICS and 27 (16%) patients underwent phacoemulsification.

**COMPARISON OF PARAMETERS WITHIN THE MSICS GROUP**

Within the MSICS group, on comparing CCT preoperative with postoperative 1 month, showed an increase of 7.08 (1.33%). Stating that there is an increase in CCT post operatively compared to preoperative. There was statistically significant variation in CCT when preoperative was compared with postoperatively (p Value = 0.000).

On comparing ECC preoperative with post operative (1 month), showed a decrease of 317.85 cells/mm2 (12.04%). Thus, stating there is a decrease of ECC in postoperative period. There was statistically significant variation in ECC when preoperative was compared with postoperative (p Value = 0.000)

On comparing CV preoperative with post operative (1 month) showed an increase of 7.41% (20.88%). Stating that there is an increase in CV post operatively. There was statistically significant variation in CV when preoperative is compared with postoperative (p Value =0.000).

On comparing %HEX preoperative with post operative (1 month),showed a decrease of 5.65 % (9.90%). Thus, stating there is a decrease of %HEX in postoperative period. There was statistically significant variation in %HEX when preoperative was compared with postoperative (p Value = 0.000)

**COMPARISON OF PARAMETERS WITHIN THE PHACOEMULSIFICATION GROUP**

Within the Phacoemulsification group, on comparing CCT preoperative with postoperative 1 month, showed an increase of 5.96 (1.13%). Stating that there is an increase in CCT post operatively compared to preoperative. There was statistically significant variation in CCT when preoperative was compared with postoperatively (p Value = 0.000).

On comparing ECC preoperative with post operative (1 month), showed a decrease of 281.70 cells/mm2 (10.67%). Thus, stating there is a decrease of ECC in postoperative period. There was statistically significant variation in ECC when preoperative was compared with postoperative (p Value = 0.000)

On comparing CV preoperative with post operative (1 month) showed an increase of 7.51% (20.23%). Stating that there is an increase in CV post operatively. There was statistically significant variation in CV when preoperative is compared with postoperative (p Value =0.000).

On comparing %HEX preoperative with post operative (1 month),showed a decrease of 4.97 % (8.59%). Thus, stating there is a decrease of %HEX in postoperative period. There was statistically significant variation in %HEX when preoperative was compared with postoperative (p Value = 0.000)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Mean** | **Mean Diff** | **Mean Diff %** | **Std. Deviation** | **p - value** |
| **CCT – Pre-OP (µm)** | **527.37** | **5.96** | **1.13013 %** | **14.57** | **0.000**  **Significant** |
| **CCT – Post- OP**  **(µm)** | **533.33** | **14.36** |
| **ECC – Pre- OP**  **(cells/mm2)** | **2639.40** | **- 281.70** | **- 10.672880 %** | **230.21** | **0.000**  **Significant** |
| **ECC – Post- OP**  **(cells/mm2)** | **2357.70** | **238.24** |
| **CV – Pre- OP**  **(%)** | **37.11** | **7.51** | **20.23713 %** | **4.90** | **0.000**  **Significant** |
| **CV – Post- OP**  **(%)** | **44.62** | **5.44** |
| **%HEX–Pre- OP**  **(%)** | **57.85** | **- 4.97** | **- 8.59118 %** | **3.04** | **0.000**  **Significant** |
| **%HEX–Post- OP**  **(%)** | **52.88** | **3.40** |

**(p Value < 0.05 is significant)**

**CCT AND ENDOTHELIAL PARAMETRES COMPARISON BETWEEN THE TWO GROUPS (MSICS AND PHACOEMULSIFICATION)**

The comparison between both groups postoperatively, showed statistically insignificant alteration in cell density of endothelial cells in cornea post operatively. (p value 0.4).

The comparison between both groups postoperatively, showed statistically insignificant alteration in Central Corneal Thickness of cornea post operatively. (p value 0.39).

The comparison between both groups postoperatively, showed statistically insignificant alteration in Co-efficient of Variation of cornea post operatively. (p value 0.05).

The comparison between both groups postoperatively, showed statistically significant alteration in Hexagonality of cells of cornea post operatively. (p value 0.01).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Group** | **N** | **Mean** | **Std. Deviation** | **p-value** |
| CCT – Post- OP (µm) | MSICS | 147 | 535.75 | 13.42 | 0.39 insignificant |
| Phaco | 27 | 533.33 | 14.36 |
| ECC – Post- OP (cells/mm2) | MSICS | 147 | 2321.50 | 219.77 | 0.4 insignificant |
| Phaco | 27 | 2357.70 | 238.24 |
| CV – Post- OP (%) | MSICS | 147 | 42.89 | 4.09 | 0.05 insignificant |
| Phaco | 27 | 44.62 | 5.44 |
| %HEX–Post- OP (%) | MSICS | 147 | 51.37 | 2.86 | 0.01 significant |
| Phaco | 27 | 52.88 | 3.40 |

**DISCUSSION**

In our study, a sample of 174 patients who were willing for cataract surgery were selected based on the inclusion and exclusion criteria. There were 87 (50%) males and 87 (50%) females and 67 (38.50%) patients were from 51- 60 years age group followed by 54 (31.03%) patients in 61 – 70 years age group. Mean age of 174 study samples was 62.58 years (standard deviation – 9.073 years), with the highest 87 years and lowest 45 years. They were divided into 2 groups based on patient’s surgery as MSICS or Phacoemulsification. All patients underwent specular microscopy before the surgery and postoperatively in the fourth week or 30 days.

In our study, patients who underwent MSICS and Phacoemulsification had increased CCT and CV and decreased ECC and %HEX values post operatively.

Cataract surgery has been known to be associated with decrease in endothelial cell density and alteration of cell morphology. The percentage of endothelial cell loss, central corneal thickness and co-efficient of variation of endothelial cells were found to be statistically insignificantly less with phacoemulsification compared to MSICS.

In correlation with our study, a study by Ganekal et al [8], where they compared the morphological and functional endothelial cell changes after MSICS versus phacoemulsification cataract surgery (chop technique) in around 200 patients using non-contact specular microscope. They found a statistically significant difference in endothelial cell density at 1 week and 6 weeks between the 2 groups.

Storr-Paulsen et al [9] compared endothelial cell damage after phacoemulsification using divide and conquer or phacoemulsification chop nuclear fracturing technique in 60 patients. Endothelial cell loss was measured postoperatively and at 3rd and 12th month. Both groups had a significant but equal decrease in cell densitycontradicting the popular hypothesis that phacoemulsification chop technique isless harmful to the corneal endothelium than divide and conquer.

Another study conducted by Gogate *et al*. comparing endothelial cell loss between phacoemulsification and MSICS in 200 patients showed the mean cell loss at 6 week postoperatively was 15.5% and 15.3%, respectively, with no statistically significant difference between the two groups. [10]

**CONCLUSION:**

The results in our study show that manual SICS is as safe for the corneal endothelium as phacoemulsification, is almost as effective, and is much more economical. These factors indicate that SICS can be an alternative to phacoemulsification in areas in which surgeons proficient in phacoemulsification and phaco machines are not available.

**REFERENCES**

1. Gupta M, Manjunath BH, Shedole SS (2020) Comparison of Morphological and Functional Corneal Endothelial Changes after Cataract Surgery under DBCS Program at a Tertiary Care Centre. J Clin Exp Ophthal. 11:823. DOI: 10.35248/2155-9570.20.11.823
2. Kudva AA, Lasrado AS, Hegde S, Kadri R, Devika P, Shetty A. Corneal endothelial cell changes in diabetics versus age group matched nondiabetics after manual small incision cataract surgery. Indian J Ophthalmol 2020; 68:72-6
3. Raut N. G. Chauhan R, Sonarkhan S. Med. Res. Chron., 2016, 3 (1), 146-155. Corneal Endothelial Cell Loss after Small Incision Cataract Surgery in Diabetic Versus Non-Diabetic Paitents.
4. Singh I, Kumar D. Specular microscopic changes in corneal endothelium after cataract surgery in different age groups. J Med Sci Clin Res.2015;3:3619-3628.
5. Muralikrishnan R, Venkatesh R, Prajna NV, et al. Economic cost of cataract surgery procedures in an established eye care centre in southern India. Ophthalmic Epidemiol. 2004; 11:369-80.
6. Jagani SN, Lune AA, Magdum RM, Shah AP, Singh M, Datta D. Comparison of endothelial cell loss by specular microscopy between phacoemulsification and manual small-incision cataract surgery.Niger J Ophthalmol 2015;23:54-9.
7. George R, Rupauliha P, Sripriya AV, Rajesh PS, Vahan PV, Praveen S. Comparison of endothelial cell loss and surgically induced astigmatism following conventional extracapsular cataract surgery, manual small‑incision surgery and phacoemulsification. Ophthalmic Epidemiol 2005;12:293‑7.
8. Ganekal S, Nagarajappa A. Comparison of morphological and functional endothelial cell changes after cataract surgery: Phacoemulsification versus manual small-incision cataract surgery. Middle East Afr J Ophthalmol 2014; 21:56-60.
9. Storr-Paulsen A, Norregaard JC, Ahmed S, Storr-Paulsen T, Pedersen TH. Endothelial cell damage after cataract surgery: divide-and-conquer versus phaco-chop technique. Journal of Cataract & Refractive Surgery. 2008 Jun 1;34(6):996-1000.
10. Gogate P, Ambardekar P, Kulkarni S, Deshpande R, Joshi S, Deshpande M. Comparison of endothelial cell loss after cataract surgery: Phacoemulsification versus manual small‑incision cataract surgery: Six‑week results of a randomized control trial. J Cataract Refract Surg 2010;36:247‑53.