Original Article

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Comparision of Endothelial Cell Loss Between Phacoemulsification and Small Incision Cataract Surgery

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Abstract

Aim: To evaluate the effect of phacoemulsification and SICS on the endothelial cell count. *Introduction:* Cataract is an important and prevalent cause of blindness worldwide. Phacoemulsification and manual small incision cataract surgery are widely practiced today. Corneal transparency is maintained by a single layer of endothelial cells, which have the ability to pump out water from corneal stroma against an osmotic gradient. Some degree of corneal endothelial loss following surgery is expected. SICS requires a great deal of maneuvering and thus direct contact with the endothelium leads to cell loss. Cell loss in phacoemulsification is dependent on the anterior chamber depth, phaco energy and method used to emulsify the nucleus, and surgical skill. *Materials and Methods:* This is one-year observational follow-up study of 100 patients, who were divided into two groups. Group A had 50 patients who underwent phacoemulsification and Group B had 50 patients who underwent SICS. TOPCON specular microscope was used to record the endothelial cell count preoperatively, 7 days postoperatively, and 42 days postoperatively. *Results:* The mean endothelial cell loss at 1 week and 6 weeks after surgery was more in Group B (278 *cells/mm*^{2}; 400 *cells/mm*^{2}) compared to Group A (278 *cells/mm*^{2}; 400 *cells/mm*^{2}) respectively, but this difference was not statistically significant. $p > 0.05$. *Conclusion:* There was no statistically or clinically significant difference between phacoemulsification or SICS in terms of endothelial cell loss.

Keywords: Endothelial cell count, Phacoemulsification, SICS, Specular microscopy.

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Introduction

Cataract is an important and prevalent cause of blindness worldwide. It accounts for 50–80% of bilateral blindness in India. Cataract is an opacification of the crystalline lens that leads to significant visual impairment. The most common cause of cataract is aging and surgery is the only plan of treatment.

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The evolution of cataract surgery started from couching and reached ECCE. Phacoemulsification is the most common surgical procedure practiced now-a-days. Manual Small Incision Cataract Surgery (SICS) is also practiced in developing countries because it is independent of advanced technology, universally acceptable, and more affordable than phacoemulsification. Both techniques achieved excellent visual outcomes with low complication rates.[1] Recently, Femtosecond laser-assisted cataract surgery is being practiced. Corneal endothelium can be adversely affected by cataract surgery.

Cornea plays an important role in visualization of an image. It is a powerful refractive medium and also a transparent medium for light rays to pass through. Corneal transparency is maintained by a single layer of endothelial cells, which have the ability to pump out water from corneal stroma against an osmotic gradient. The endothelial cells cannot regenerate after injury; they repair by enlarging.[2] Mean endothelial cell count of adult cornea is *2000–2500 cells/mm*.[2] Endothelial Cell Count (ECC) decreases as the age advances. When ECC reaches *400–600/mm*^{2}, it is the point at which endothelial decompensation and loss of corneal clarity occurs.[3] Some degree of endothelial cell loss after any cataract surgery is inevitable and is acceptable. SICS is more damaging to the endothelium when compared to phacoemulsification because of the extensive manipulation in the anterior chamber during the surgery. Maneuvering is mechanical and performed within the capsular bag in the case of phacoemulsification, relatively far from the endothelium.

Phacoemulsification is performed in a limited space so a deeper anterior chamber has a protective effect on the corneal endothelium by decreasing intra-operative damage. Pre-operative anterior chamber assessment should be done to anticipate any intra-operative complications. Moreover, the divide-and-conquer method causes more endothelial damage than the phaco chop technique by using more phaco energy to chop and phacoemulsify the nucleus.[4]

Specular microscopy is the study of corneal layers under very high magnification. The endothelial cell shape, size, density, and distribution can be analyzed. Light source is placed at a *30° angle* to the cornea and the microscope at a *30° angle* on the other side of the cornea. The light beam passes through the cornea and it encounters a series of interfaces between the optically distinct layers. Some of the light is reflected back to the photomicroscope and forms an image of the endothelial surface. TOPCON SP-2000P gives highly repeatable and reproducible values for endothelial cell density and average endothelial cell size.[5]

Materials and Methods

This is an observational follow-up study of 100 patients conducted in Narayana Medical College and Hospital over the span of one year from *April 2018* to *April 2019*. Cases were divided into two groups, Group A had 50 patients who underwent phacoemulsification and Group B had 50 patients who underwent SICS. Study was done on the patients admitted for cataract surgery in department of ophthalmology. Consent was taken to include the patient in the study.

Inclusion criteria

1. Patients between the age group *45–90 years*;
2. Immature senile cataract Nuclear Sclerosis 1–3;
3. Cortical cataract;
4. Posterior subcapsular cataract;
5. Clear cornea.

Exclusion criteria

1. Mature cataract;
2. Hypermature cataract;
3. Nuclear sclerosis Grade 4;
4. Traumatic cataract;
5. Glaucoma;
6. Corneal surgeries;
7. Ocular trauma;
8. Uveitis;
9. Intraoperative complications during cataract surgery–premature entry, posterior capsule rupture;
10. Low pre-operative endothelial count *<1500 mm*^{2};
11. Post-operative complications–displaced PCIOLs, wound leak.

Pre-operative Evaluation

Patients' details were taken and routine pre-operative cataract evaluation and investigations were done. The decision of whether to perform SICS or Phacoemulsification was taken. Endothelial cell count was obtained one day prior to surgery using a TOPCON specular microscope. Following the surgery, endothelial cell count was recorded on the *7*th *(1 week) postop day* and *42*nd *postop day (6 weeks)*.

Surgical Procedure

All cases were performed under peribulbar anesthesia. Under aseptic conditions the eye which was to be operated was prepped withpovidone iodine and draped. Eyelids were retracted using wire speculum.

SICS

A superior rectus bridle suture was placed and a conjunctival peritomy done from *10–2 o'clock* position to exposed the sclera. Diathermy was used to cauterize the incisional area. Scleral incision was made and a sclerocorneal tunnel upto *1–1.5 mm* into the clear cornea. Viscoelastic substance was injected and continuous curvilinear capsulorhexis followed by entry into the anterior chamber using a blade was performed. Hydrodissection and hydrodelineation of the nucleus was performed using a 26-gauge hydro cannula and the nucleus was prolapsed into the anterior chamber. An irrigating Vectis was passed under the nucleus and drawn into the tunnel. Remaining cortical matter was removed with Simcoe cannula and polymethyl methacrylate intraocular lens was placed. The anterior chamber was irrigated with irrigation fluid using a Simcoe cannula. The wound is self-healing. Subconjunctival steroid and antibiotic injection were given, the lids were closed, and dressing was applied.

Phacoemulsification

A superior rectus bridle suture was placed and a clear corneal incision of *3 mm* was made and entry performed with *3.2 mm* lancet microkeratome. A side port entry of *1 mm* size was made *45°* from the entry wound. Ocular viscoelastic substance was injected into the anterior chamber. Capsulorhexiswas performed with a cystotome in a viscoelastic substance filled anterior chamber. Hydrodissection and hydrodelineation of the nucleus was performed. Nucleus was prolapsed into the anterior chamber by the use of an intraocular lens dialer. VES was injected into the anterior chamber and emulsification done in a divide-and-conquer method. Vacuum settings of *70 mm Hg*, aspiration flow rate of *15–20 cc/min* and maximum power rate of 70% was used. Remaining cortical matter was removed with a Simcoe cannula and PMMC intraocular lens was placed. Anterior chamber was irrigated with irrigating fluid using a Simcoe cannula. Subconjunctival steroid and antibiotic injections were given and the eye was closed and dressing was done.

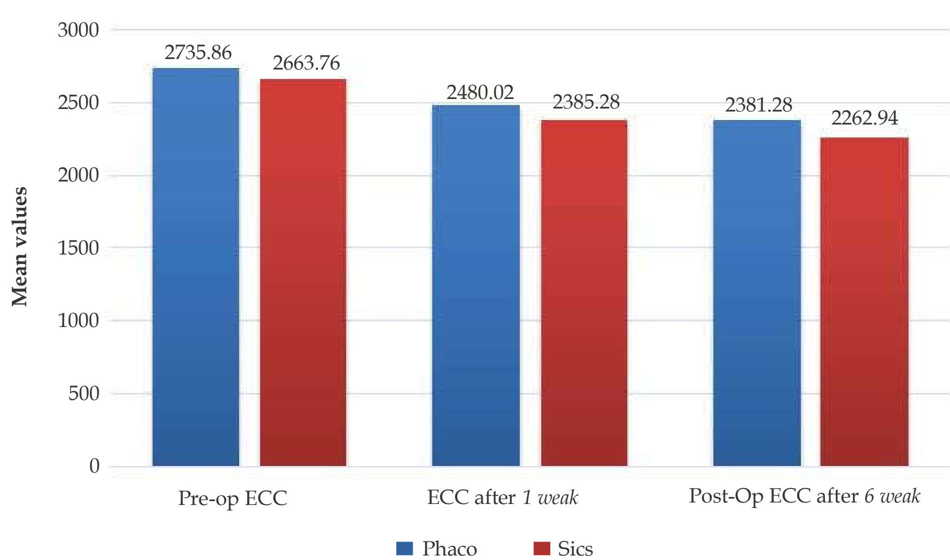
Results

The study was conducted on 100 individuals. Group A with 50 members who underwent phacoemulsification, Group B had 50 members who underwent small incision cataract surgery. Mean age of patients was *61.64 ± 6.8 years* and *61.42 ± 7 years* in Group A and B respectively. Group A had 42% males and 58% females, Group B had 44% males and 56% females. There is no statistical difference among 2 groups as per the age and sex.

The endothelial cell count in Group A was *2735.86 cells/mm^2* pre-operatively (C1), *2480.02 cells/mm^2* (C2) at *1 week* and *2381.28 cells/mm^2* (C3) at *6 weeks* post-operative period. The endothelial cell count in Group B was *2663.76 cells/mm^2* (C1) preoperatively, *2385.28 cells/mm^2* (C2) at *1 week* and *2262.94 cells/mm^2* (C3) at *6 weeks* post-operative period, **(Table 1) & (Graph 1)**.

Table 1: Endothelial Cell Count

	C1	C2	C3
Group A	2735.86	2480.02	2381.28
Group B	2663.76	2385.28	2262.94

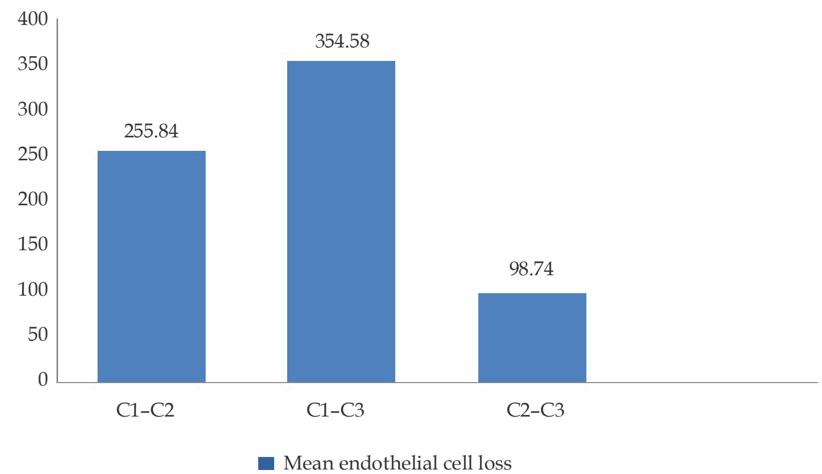


Graph 1: Endothelial cell count.

In the present study, in Group A; the mean endothelial loss *1 week* after surgery was *255.84 cells/mm²* (C1–C2) and *6 weeks* after surgery was *354.48 cells/mm²* (C1–C3), between *1 week* and *6 weeks* after surgery was *98.74 cells/mm²* (C2–C3). The mean cell loss was statistically significant ($p < 0.0001$), **(Table 2)** & **(Graph 2)**.

Table 2: Mean Endothelial Cell Loss–Group A

Mean endothelial cell loss	Cell loss (cells/mm²)	Standard deviation	*t* Value	*p* Value
(C1–C2)	255.84	52.012	34.781	<0.0001
(C1–C3)	354.58	64.915	38.624	<0.0001
(C2–C3)	98.74	40.981	17.037	<0.0001

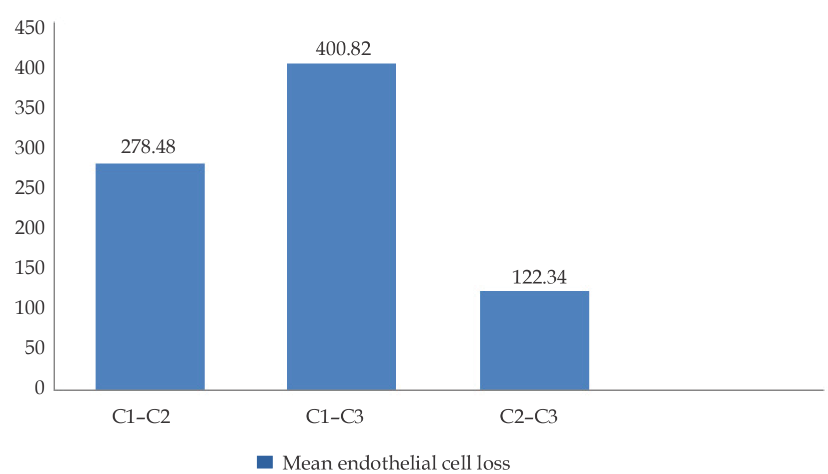


Graph 2: Endothelial cell loss in Group A

In Group B; the mean endothelial loss *1 week* after surgery was *278.48 cells/mm²* (C1–C2) and *6 weeks* after surgery was *400.82 cells/mm²* (C1–C3), between *1 week* and *6 weeks* after surgery was *122.34 cells/mm²* (C2–C3). The mean cell loss was statistically significant ($p < 0.0001$), **(Table 3)** & **(Graph 3)**.

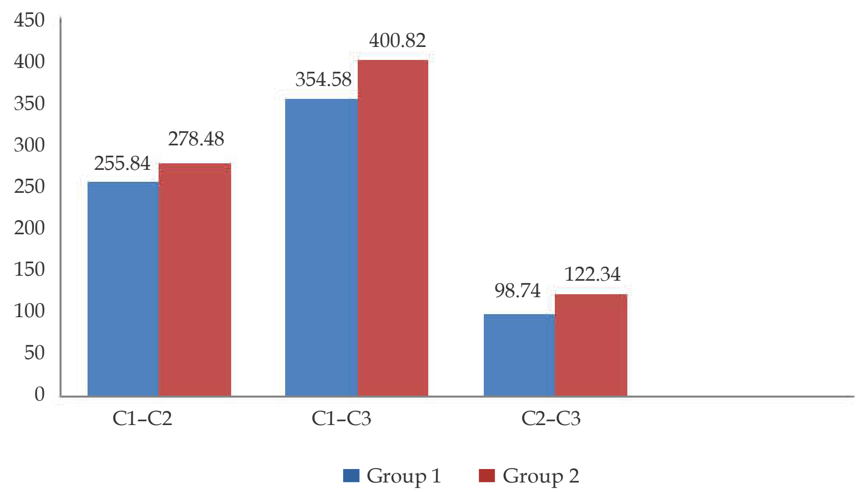
Table 3: Mean Endothelial Cell Loss-Group B

Mean endothelial cell loss	Cell loss	Standard deviation	*t* Value	*p* Value
(C1–C2)	278.48	63.507	31.007	<0.0001
(C1–C3)	400.82	75.962	37.311	<0.0001
(C2–C3)	122.34	34.514	25.065	<0.0001



Graph 3: Endothelial cell loss in Group B

The endothelial cell loss at *1 week* and *6 weeks* pos-toperative period is 9.4% and 13.14% in phacoemulsification and 10.6% and 15.3% in SICS respectively. The cell loss is more in SICS than in phacoemulsification, the difference being statistically insignificant (p >0.05).



Graph 4: Comparison with endothelial cell loss in Group A & B

Discussion

In our study, the mean endothelial cell loss in Group A and Group B was 9.4% and 10.6% at *1 week;* and 13.14% and 15.3% at *6 weeks*; and 4.06% and 5.25% between *1 week* to *6 weeks* respectively. The difference between the groups was statistically insignificant. There are several other studies that were consistent with ourresults.

The study conducted by Bourne and colleagues, comparing endothelial count in patients undergoing phacoemulsification and ECCE concluded there was an average of 10% reduction in cell count at *1 year* post-operatively. Difference of endothelial count between the two groups was not statistically significant.[6] In another study conducted by Dı´az-Valle *et al*. compared the endothelial damage between phacoemulsification, ECCE with continuous curvilinear capsulorhexis and ECCE with letter box capsulotomy. There was significant loss of endothelial cells in all the three groups and there was no statistical difference among the three groups.[7]

In the study conducted by Ravalico and colleagues, the endothelial cell loss between phacoemulsification and ECCE[8] was compared, no significant difference was found in the endothelial cell loss between the two Groups. In Gogate *et al*. study where endothelial cell loss in phacoemulsification and manual SICS was compared, concluded there was no significant difference in endothelial cell loss between the two Groups, the cell loss being 15.5% in phacoemulsification and 15.3% in SICS.[9] In another study conducted by George *et al*., where the endothelial cell loss was compared among conventional ECCE, manual SICS and phacoemulsification. Conclusions of the study are there is no statistically significant difference in the cell loss among three Groups at 6 weeks post-operative perioid.[10]

The study conducted by Jiang T *et al*., compared the effects of phacoemulsification and SICS in aged individuals. Conclusion of the study is there is no significant difference in endothelial cell loss between the two groups, with cell loss being 18.6% in phacoemulsification and 19% in SICS patients.[11]

The corneal endothelium is an important factor responsible for maintaining corneal transparency. It is an important factor in evaluating the safety of any intraocular surgery.[12] Whatever is the cataract surgery chosen, may lead to endothelial cell loss causing corneal edema and it recovers early in most of the cases. Such recovery depends on many factors such as surgical technique, OVD and irrigating fluid used. Regarding endothelial cell loss post-operatively, several studies conducted have given different results.

In the study conducted by Somil *et al*. compared the endothelial cell count in phacoemulsification and manual SICS. Phacoemulsification was divided into 2 Groups, one with temporal clear corneal incision and the other with superior incision. There was no statistical or clinical significance between the two Groups. Among phacoemulsification cases, superior incision had less endothelial loss at *1 week* post-operative period and was statistically significant, but the difference was insignificant at *6 weeks* and *3 months* post-operative period.[13]

Our study has few shortcomings. We used irrigating vectis for manual SICS. Hydroxypropyl methylcellulose (HPMC) was used in all cases instead of endothelial protective viscoelastic agents like Viscoat and Healon. And moreover, stainless steel blades were used instead of diamond knives. Another drawback of the study is short term follow-up for only *6 weeks*.

Conclusion

Inspite of the advanced technology available in the management of cataract, it still remains the most important cause of blindness. In any cataract surgery, significant loss of endothelial cells appears to occur, and leads to reduced clarity in vision due to corneal decompensation, so we need to know the surgical procedure that has less endothelial loss and better visual acuity. In our study, there was no statistically or clinically significant difference between phacoemulsification or SICS in terms of endothelial cell loss. Manual SICS is the preferred surgery in developing countries because it is more economical than phacoemulsification.

Conflicts of interest: None

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