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A Comparative Study of Corneal Endothelial Cell Loss Using Specular Microscopy in Phacoemulsification and Small Incision Cataract Surgery (SICS) in A Tertiary Health Care Center

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Abstract

Introduction

Cataract surgery is one of the most frequently performed surgeries worldwide, with Phacoemulsification and Small Incision Cataract Surgery (SICS) being the two dominant methods. Both techniques aim for cataract extraction and restoration of vision, but they differ in their impact on the corneal endothelium, which plays a critical role in maintaining corneal transparency. Endothelial cell loss during surgery can lead to complications such as corneal decompensation. This study compares the endothelial cell loss following Phacoemulsification and Small Incision Cataract Surgery using specular microscopy, particularly in patients with advanced cataracts (nuclear sclerosis grade III and IV).

Methods

This comparative, prospective study was conducted in a tertiary healthcare setting. A total of 101 patients underwent cataract surgery, with 53 undergoing Phacoemulsification and 48 undergoing SICS. Preoperative and postoperative endothelial cell counts

were measured using non-contact specular microscopy. Postoperative measurements were taken on days 1, 7, and 28. Data analysis focused on comparing the percentage of endothelial cell loss between the two surgical techniques and assessing any correlations with cataract grade.

Results

The study revealed that Phacoemulsification resulted in greater endothelial cell loss at all postoperative time points compared to SICS. On postoperative day 1, Phacoemulsification showed an average endothelial cell loss of 8.49%, compared to 6.33% for SICS. By day 28, the loss had increased to 16.59% for Phacoemulsification and 14.26% for SICS. The difference between the two groups was statistically significant, with Phacoemulsification consistently leading to more endothelial cell loss across grades of cataract included in study. Both surgical techniques demonstrated significant cell loss from preoperative values, with no significant variation in cell loss between nuclear sclerosis grades III and IV within each surgical group.

Conclusion

This study concludes that Phacoemulsification causes more endothelial cell loss compared to SICS in patients with grade III and grade IV nuclear sclerosis, with the difference being statistically significant at all postoperative time points. Given the greater safety profile in terms of endothelial preservation, SICS may be a more suitable option, particularly in resource-limited settings or for patients with a higher risk of corneal endothelial damage. Further studies with larger sample sizes and longer follow-up periods are recommended to confirm these findings.

Keywords: Cataract surgery, Phacoemulsification, Small Incision Cataract Surgery (SICS), Endothelial cell loss, Specular microscopy, Corneal endothelium, Nuclear sclerosis

Introduction

Blindness is one of the major health problems in developing countries. According to the World Health Organization (WHO), cataract is the major cause of vision loss and blindness followed by glaucoma and corneal diseases. Overall proportion of avoidable blindness and visual impairment in India are 92.9% and 97.4% respectively. Out of these, untreated cataract and complications due to cataract surgery comprises 73.4 % cases of blindness. The National Blindness and Visual Impairment Survey 2019 of India reported that cataract was the leading cause of blindness and visual impairment among patients more than 50 years of age accounting for 66.2%. [(1)] is responsible for 50%–80% of bilateral blindness in our country. [(2)] Cataract surgical coverage (CSC) among cataract blinds (Visual acuity VA < 3/60 in better eye) was 93.2% (males 93.8% and females 91.9%). Cataract surgical coverage amongst visually impaired (VA <6/18 in better eye) due to cataract was 74.00%. [(1)]

The Corneal endothelial cell is a single layer of polygonal, hexagonal cells. The mean endothelial cell count is about 2000-2500/mm2 in a normal adult life. The endothelial cell count at birth is 3000/mm2 and decreases with increasing age. The rate of declination of endothelial cells is 0.3 - 0.6% per year. [(3,4)] Corneal endothelial cells maintain transparency and dehydrated state of corneal stroma by Na+/K+ ATPase pump activity by generation of bicarbonate ion gradient across the corneal endothelium. If endothelial cell count is below 400-500 cells/mm^2, the cornea is compromised

postoperatively, and corneal decompensation develops. [5, 6]

Two primary techniques, Phacoemulsification and Small Incision Cataract Surgery (SICS) are widely used in cataract extraction. While both techniques are effective in cataract removal, they differ significantly in their approach, instrumentation, and potential impact on the corneal endothelium. The corneal endothelial cells' integrity is crucial for maintaining corneal clarity and overall ocular health, making the evaluation of endothelial cell loss post-surgery a vital concern.[7] A government healthcare setting, where resources are often limited, it is essential to optimize surgical outcomes while minimizing complications. A comparative study in this context can help establish evidence-based protocols that ensure high-quality care with efficient use of available resources.

Given the increasing prevalence of cataracts due to an aging population, the results of this study could have significant implications not only locally but also globally. Establishing the safest and most effective surgical technique for cataract extraction will contribute to improved surgical outcomes and patient satisfaction on a broader scale.

The study will address a critical aspect of cataract surgery—corneal endothelial cell preservation—which directly impacts patient outcomes. The results will provide valuable insights that can enhance surgical techniques, improve postoperative care, and ultimately contribute to better visual health outcomes in the public healthcare system.

Material and Methods

- The study was an observational, prospective study carried out at tertiary care Center of South Gujarat between January 2023 to December 2023 to document endothelial cell loss post - cataract surgery in patients with grade 3 and 4 Nuclear Sclerosis and to compare endothelial cell loss in Phacoemulsification and Small Incision Cataract Surgery (SICS).

Total 101 eyes of 101 patients underwent surgical procedure – Phacoemulsification or Small incision cataract surgery and were then divided into 2 groups.

Group 1: Phacoemulsification

Group 2: Small Incision Cataract Surgery

Total 53 patients underwent Phacoemulsification surgery and 48 patients underwent small incision cataract surgery.

This study was conducted with approval of the institutional ethical committee.

All the patients enrolled in the study were examined after giving proper information about the study and taking informed written consent.

Inclusion Criteria

- Those who give written consent for participation in study.
- Age group of patients 50 – 80 years.
- Pre - Operative Corneal Endothelial Cell count between 1500/mm3 - 3000/mm2.
- NUCLEAR SCLEROSIS 3 and 4 - Cataract grading according to LOCS 3 Criteria.

Exclusion Criteria

- Patients with a history of Diabetes Mellitus.
- History of previous eye surgery.
- History of ocular trauma - Traumatic Cataract.
- Corneal Endothelial Cell count less than 1500/mm3.
- Patients with pre-existing Corneal Pathology.
- Preoperative diagnosed with Glaucoma.
- Hard cataract grade 5 and 6

- Any intraoperative complication (Example: Posterior capsular rent)
- Intraoperative use of any medications affecting corneal cell count. (Example: Epitrate, Pilocarpine)

Methodology

Preoperative evaluation:

Preoperative evaluation of all patients fulfilling the inclusion criteria was carried out and a detailed history was taken followed by systemic and ocular examination.

1. Demographic data (patient's name, age, sex, address and occupation) was noted.
2. A detailed medical and ophthalmic history was taken.
3. Assessment of routine parameters
   - Visual Acuity
   - Slit lamp examination for anterior segment evaluation and cataract grading
   - Keratometry
   - A-Scan
   - Preoperative non-contact specular microscopy: It was done using TOPCON SP 3000P specular microscope.
   - Fundoscopy

Preoperative medication

- Patients were instructed to apply MOXIFLOXACIN (0.5%) eye drops (antibiotics) topically every hour on the day prior to the surgery.
- Flurbiprofen (0.03%) eye drops (NSAIDs) were given 3 – 4 times day before surgery to prevent inflammation and intraoperative miosis.
- Phenylephrine (5%) as well as Tropicamide (0.8%) eye drop has been employed every 10-15 minutes commencing an hour before surgery to dilate the operating eye.

Anaesthesia

Every patient undergoing surgery received a 7 ml peribulbar block containing hyaluronidase, 2% lignocaine, and 1:1000 adrenaline.

Surgical procedure

SICS [Small Incision Cataract Surgery]

- Once all sterile procedures were finished, the superior rectus bridle suture was threaded, and secured to the towel, and a single drop of 5% povidone iodine was administered into the conjunctival sac. A drape was then placed over the eye, and a universal wire speculum was inserted.
- From 10 to 2 o'clock, a conjunctival flap based on the fornix was developed.
- The sclera was revealed, and thermal cautery was used to induce haemostasis.
- A 5.5–7.5mm scleral incision had been made 1.5–2mm distant from the limbus, or around one-third of the sclera's thickness.
- Using a 2.8mm crescent knife, the scleral pockets on either side had been split to create the sclerocorneal tunnel.
- A side port was created at the 9 o'clock position. Following this, the capsule was stained with trypan blue dye. Subsequently, an OVD (Ocular Viscoelastic Device) [Hydroxypropyl methyl cellulose 2%] was injected into the anterior chamber.
- Continuous curvilinear capsulorhexis had been done using a 26G cystitome.
- The 3.2mm keratome was employed to access the AC.
- After performing hydrodissection and hydrodelineation, the nucleus prolapsed into AC.

- AC had an injection of OVD, and the nucleus was delivered.
- The cortex was irrigated and aspirated.
- Again, OVD was injected into AC, and a rigid PMMA/FOLDABLE IOL was placed inside the capsular bag.
- Aspiration cannula and two-way irrigation are employed to remove OVD.
- AC formed with saline.
- Through BSS hydration, the side port was sealed.
- Conjunctival flap was placed back and cauterised.

Phacoemulsification

- Following the implementation of all aseptic measures, the eye had been treated with 10 percent povidone iodine (skin), a drape had been placed over it, a universal wire speculum had been positioned, as well as a single drop of 5 percent povidone iodine had been instilled into the conjunctival sac.
- For the Phacoemulsification probe, an incision of 2.8mm in diameter was created in the clear cornea, and two 0.8 mm side ports were created.
- After trypan blue stained the anterior capsule, HPMC 2 percent had been introduced into the anterior chamber as well as a continuous curvilinear capsulorhexis had been carried out using a cystitome.
- Adequate hydrodissection and hydrodelineation have been carried out.
- Using the Divide and Conquer method, the nucleus was then Phacoemulsification.
- Using a bimanual irrigation along with aspiration approach, the remaining cortical lens materials were aspirated.
- Utilizing an injector system, a viscoelastic material had been injected into the anterior chamber before the foldable IOL had been placed into the capsular bag.
- Aspiration cannula and two-way irrigation are used to remove OVD.
- AC formed with saline.
- Wet them with BSS to seal all of the wounds.
- It was ensured that same concentration of balanced salt solution, blue dye, viscoelastic and same type of posterior chamber intraocular lens was used in all the surgeries of group 1 and group 2 cases. The outcome measures were preoperative and postoperative endothelial cell count at day 1, day 7 and day 28 and percentage of endothelial cell loss at day 1, day 7 and day 28.

Postoperative medication

It included oral antibiotics, oral analgesics, topical antibiotics, topical steroids, topical cycloplegics, topical NSAIDs and if required oral acetazolamide.

Follow up

The patients were followed up on day 1, day 7 and day 28 for specular microscopy for corneal endothelial cells analysis.

Statistical analysis

- The data was collected with predesigned proforma and entered in Microsoft Excel and analysed by using SPSS version 26.
- Univariate analysis: All normally distributed data will be presented as mean standard deviation (SD). Categorical data will be analysed as proportions.
- Bivariate analysis: Differences in baseline characteristics between the groups will be assessed by a parametric test (Student t test).
- Multivariate analysis: Multiple linear regressions will be performed to assess the effect of various

determinants in Phacoemulsification and Small Incision Cataract Surgery.

Result and discussion

In this study, 101 eyes of 101 patients were included that underwent cataract surgery. They were categorised as follows:

Group 1: Phacoemulsification [53 eyes]

Group 2: Small Incision Cataract Surgery [48 eyes]

Table 1: Overall mean Age

	Total	Minimum	Maximum	Mean	Std. Deviation
Age	101	50	80	64.91	8.035

Table: 2 Age group Distribution

Age group	Number of patients	Percentage
50	4	4.0
51-60	32	31.7
61-70	40	39.6
71-80	25	24.8
Total	101	100.0

The study included the patients between the age group of 50 to 80 years. Majority of patients were between the age of 61 to 70 years (39.6%). The mean age of presentation was 64.91 ± 8.035 years.

Similar findings were observed in previous similar studies

In **Jagani et al** [8] in **2015** conducted a similar study which included 200 eyes of 200 patients with mean age of 63.78 ± 8.36 in SICS and 62.46 ± 8.71 in Phacoemulsification group.

In **Tejinder et al** [9] in **2016** conducted a similar study which included 200 eyes of 200 patients with mean age of 59.01± 10.57 in SICS and 57.25 ± 9.61 in Phacoemulsification group.

In **Gupta R et al** [10] in **2024** conducted a similar study which included 120 eyes of 120 patients with mean age of 64.25 ± 9.53 in SICS and 62.50 ± 8.87 in Phacoemulsification group.

Table 3: Distribution of patients according to gender (N = 101)

Sex	Number of patients	Percentage
Female	57	56.4
Male	44	43.6
Total	101	100.0

(N = 101 - Number of patients in the study)

In the present study, out of 101 participants, 57 (56.4%) were females and 44 (43.6%) were males. The sex ratio of the study was about 1.29:1 [Females: Males]

Jagani et al [8] in **2015** did a similar study in which out of 200 participants, 109 (54.5%) were females and 89 (44.5%) were males. The sex ratio of the study was about 1.22:1 [Females: Males]

Mohan et al [11] in **2022** did a similar study in which out of 124 participants, 74 (59.67%) were females and 50 (40.33%) were males. The sex ratio of the study was about 1.48:1 [Females: Males]

Table 4: Distribution of patients according to cataract grading

Cataract Grading	Frequency	Percentage
NS III	68	67.3
NS IV	33	32.7
Total	101	100.0

Table 5: Distribution of the patients according to cataract grading and technique of cataract surgery

	Group 1 Phacoemulsification	Group 2 SICS	Total
NS III	43	25	68
NS IV	10	23	33
	53	48	101

Table 6: Pre-operative endothelial cell count

Endothelial cell count	Number of eyes
2000-2250	05
2251-2500	45
2501-2750	40
2751-3000	11
Total	101

Table 7: Overall Endothelial cell count (ECC)

	Minimum	Maximum	Mean	Std. Deviation
PRE-OP	2161	2881	2516.52	162.609
POD 1	1952	2711	2328.48	162.085
POD 7	1859	2639	2226.00	163.603
POD 28	1746	2532	2126.77	167.001

Table 8: Comparison of endothelial cell count in Phacoemulsification and small incision cataract surgery

	Phacoemulsification (n=53)	SICS (n=48)	p-value
PRE-OP	2507±159.68	2527.04±166.84	0.539
POD 1	2293.68±155.79	2366.9±161.78	0.023
POD 7	2186.15±152.23	2270±165.97	0.009
POD 28	2090.81±154.86	2166.48±172.46	0.022
p-value	<0.0001	<0.0001	

In our study, group 1 - Phacoemulsification (n = 53) had a preoperative endothelial cell count of 2507±159.68 / mm^2. Postoperative endothelial cell counts on day 1, day 7 and day 28 were 2293.68 ±155.79/mm^2, 2186.15±152.23/mm^2 & 2090.81±154.86/mm^2 respectively. P value for the group at the end of 28th postoperative day was p<0.0001 which is suggestive of significant endothelial cell count decrease from preoperative value.

In our study, group 2 - SICS (n = 48) had a preoperative endothelial cell count of 2527.04 ± 166.84 / mm^2. Postoperative endothelial cell counts on day 1, day 7 and day 28 were 2366.9±161.78/mm^2, 2270±165.97/mm^2 and 2166.48±172.46/mm^2 respectively. P value for the group at the end of 28th postoperative day was p<0.0001 which is suggestive of significant endothelial cell count decrease from preoperative value.

The preoperative P value between 2 groups is 0.539 suggestive that there is no significant difference between the two groups before surgery, indicating comparable starting conditions for both.

P value at postoperative day 1 comparing endothelial cell count between 2 groups was 0.023, at postoperative day 7 was 0.009 and at postoperative day 28 was 0.022 suggestive that the overall mean endothelial cell count in group 2 – SICS is significantly higher than the endothelial cell count in group 1 – Phacoemulsification across all postoperative points.

Table 9: Endothelial cell loss in Phacoemulsification and SICS

	Group 1 Phacoemulsification	Group 2 SICS	p-value
POD1	213.33±18.23	160.15±21.13	<0.0001
POD7	320.85±18.96	257.05±12.73	<0.0001
POD28	416.19±34.86	360.57±14.52	<0.0001

Table 10: Post-operative endothelial cell loss in Phacoemulsification and SICS:

	ECC (Phacoemulsification)	ECL (Phacoemulsification)	% ECL (Phacoemulsification)	ECC (SICS)	ECL (SICS)	% ECL (SICS)
Pre-operative	2507			2527.04		
POD – 1	2293.68	213.33	8.49	2366.90	160.14	6.33
POD – 7	2186.15	320.85	12.79	2270	257.04	10.17
POD – 28	2090.81	416.19	16.59	2166.48	360.56	14.26

The endothelial cell loss occurring was analysed.

The mean endothelial cell loss on postoperative day 1 in group 1 -Phacoemulsification surgery was 213.33±18.23 cells/mm^2 (8.49%) and in group 2 - SICS was 160.15±21.13 (6.33%) cells/mm^2 with p value of p < 0.0001 which is suggestive of **significant cell loss on postoperative day 1 in both groups**, where loss in Phacoemulsification group is higher than that of SICS group.

The mean endothelial cell loss on postoperative day 7 in group 1 - Phacoemulsification surgery was 320.85±18.96 (12.79%) cells/mm^2 and in group 2 - SICS was 257.05±12.73 cells/mm^2 (10.17%) with p value of p < 0.0001 which is suggestive of **significant cell loss on postoperative day 7 in both groups**, where loss in Phacoemulsification group is higher than that of SICS group.

The mean endothelial cell loss on postoperative day 28 in group 1 - Phacoemulsification surgery was 416.19±34.86 cells/mm^2 (16.59%) and in group 2 - SICS was 360.57±14.52 cells/mm^2 (14.26%) with p value of p < 0.0001 which is suggestive of **significant cell loss on postoperative day 28 in both groups**, where loss in Phacoemulsification group is higher than that of SICS group.

Endothelial cell loss was 16.59% in Phacoemulsification group and 14.26% at the end of 28th postoperative day.

Table 11: Comparison of endothelial cell count between Group 1 [Phacoemulsification] and group 2 [SICS] with different cataract grading

	Group1[Phacoemulsification]			Group 2 [SICS]		
	NS-III	NS-IV	p-value	NS-III	NS-IV	p-value
PRE-OP	2508.19± 158.39	2501.9± 173.81	0.912	2567.08± 132.15	2483.53± 191.35	0.083
POD 1	2294±154.47	2292.3± 169.94	0.976	2404.6± 127.35	2325.92± 186.69	0.093
POD 7	2187.75± 149.89	2179.3± 170.24	0.876	2311.04± 132.24	2225.4± 189.15	0.074
POD 28	2091.07± 154.46	2089.7± 165	0.98	2209.76± 138.91	2119.44± 195.06	0.069
p-value	<0.0001	<0.0001		<0.0001	<0.0001	

In our study, as discussed 53 patients underwent Phacoemulsification surgery and 48 patients underwent SICS. Out of 53 patients in group 1 (Phacoemulsification), 43 patients had NS III and 10 patients had NS IV grade of cataract. In group 2 (SICS), out of 48 patients, 25 patients had NS III and 23 patients had NS IV cataract.

Preoperative and postoperative endothelial cell count according to grades of cataract was analysed in those 2 groups.

In group 1 – Phacoemulsification, in patients with NS III cataract, preoperative endothelial cell count was 2508.19± 158.39/mm^2. Postoperative ECC on day 1, day 7 and day 28 were 2294±154.47/mm^2, 2187.75± 149.89/mm^2 and 2091.07± 154.46/mm2 respectively. P value = <0.0001 which signifies **significant endothelial cell count from the preoperative value** at the end of 28th postoperative day.

In group 1 – Phacoemulsification, in patients with NS IV cataract, preoperative endothelial cell count was 2501.9± 173.81/mm^2. Postoperative ECC on day 1, day 7 and day 28 were 2292.3± 169.94/mm^2, 2179.3± 170.24/mm^2 and 2089.7± 165/mm2 respectively. P = <0.0001 which

signifies **significant endothelial cell count from preoperative value** at the end of 28th postoperative day.

In group 2 – SICS, in patients with NS III cataract, preoperative endothelial cell count was 2567.08± 132.15/mm^2. Postoperative ECC on day 1, day 7 and day 28 were 2404.6± 127.35/mm^2, 2311.04± 132.24/mm^2 and 2209.76± 138.91/mm2 respectively. P = <0.0001 which signifies **significant endothelial cell count from the preoperative value** at the end of 28th postoperative day.

In group 2 – SICS, in patients with NS IV cataract, preoperative endothelial cell count was 2483.53± 191.35/mm^2. Postoperative ECC on day 1, day 7 and day 28 were 2325.92± 186.69/mm^2, 2225.4± 189.15/mm^2 and 2119.44± 195.06/mm2 respectively. P = <0.0001 which signifies **significant endothelial cell count from the preoperative value** at the end of 28th postoperative day.

The preoperative p value for endothelial cell count in group 1 (Phacoemulsification – NS III and NS IV cataract) is p = 0.912 which is suggestive that the **preoperative ECC in both groups (NS III and NS IV Phacoemulsification) is not statistically significant.** For postoperative day 1 it is p = 0.976, for day 7 p = 0.876 and for day 28 p = 0.98 which is not statistically significant and states that the endothelial cell count in NS III and NS IV cataract in patients undergoing Phacoemulsification is almost similar across the postoperative points.

The preoperative p value for endothelial cell count in group 2 (SICS - – NS III and NS IV cataract) is p = 0.083 which is suggestive that the preoperative ECC in both groups (NS III and NS IV SICS) is not statistically significant. For postoperative day 1 it is p = 0.093, for day 7 p = 0.074 and for day 28 it is p = 0.069 which is not statistically significant and states that the endothelial cell count in NS III and NS IV cataract in patients undergoing SICS is almost similar across the postoperative points.

While both Phacoemulsification and SICS result in significant endothelial cell loss over time (p < 0.0001), the differences between nuclear sclerosis grades (NS-III and NS-IV) within each group are not statistically significant. However, **SICS** appears to preserve more endothelial cells across all time points compared to **Phacoemulsification**, making it a preferable choice, especially in patients with denser cataracts

Table 12: Comparison of endothelial cell loss between Group 1 [Phacoemulsification] and group 2 [SICS] with different cataract grading

	Phacoemulsification		p-value	SICS		p-value
	NSIII	NSIV		NSIII	NSIV	
POD1	214.19±19.3	209.6±12.78	0.479	162.48±13.81	157.61±27.07	0.431
POD7	320.45±19.49	322.6±17.34	0.749	256.04±13.52	258.14±12.02	0.575
POD28	417.12±38.11	412.2±14.89	0.692	357.32±14.43	364.09±14.07	0.107

Table 13: Post-operative endothelial cell loss in SICS according to Cataract grading

	NS III		NS IV	
	Endothelial cell count (ECC)	Endothelial cell loss (ECL) (%)	Endothelial cell count (ECC)	Endothelial cell loss (ECL) (%)

Pre-operative	2567.08	-	2483.53	-
POD - 1	2404.60	162.48 (6.32)	2325.92	157.61 (6.34)
POD – 7	2311.04	256.04 (9.97)	2225.40	258.14 (10.39)
POD - 28	2209.76	357.32 (13.92)	2119.44	364.09 (14.66)

In group 1 – Phacoemulsification, in patients with NS III cataract postoperative endothelial cell loss on day 1, day 7 and day 28 were 214.19±19.3 cells/mm^2 (8.53%), 320.45±19.49 cells/mm^2 (12.77%), and 417.12±38.11 cells/mm2 (16.63%) respectively.

In group 1 – Phacoemulsification, in patients with NS IV cataract postoperative endothelial cell loss on day 1, day 7 and day 28 were 209.6±12.78 cells/mm^2 (8.37%), 322.6±17.34 cells/mm^2 (12.89%) and 412.2±14.89 cells/mm2 (16.47%) respectively.

In group 2 – SICS, in patients with NS III cataract postoperative endothelial cell loss on day 1, day 7 and day 28 were 162.48±13.81cells/mm^2 (6.32%), 256.04±13.52 cells/mm^2 (9.97%) and 357.32±14.43 cells/mm2 (13.92%) respectively.

In group 2 – SICS, in patients with NS IV cataract postoperative endothelial cell loss on day 1, day 7 and day 28 were 157.61±27.07 cells/mm^2 (6.34%), 258.14±12.02 cells/mm^2 (10.39%) and 364.09±14.07 cells/mm2 (14.66%) respectively.

The P value for endothelial cell loss on postoperative day 1, 7 and 28 in Phacoemulsification group for NS III and NS IV cataract are 0.479, 0.749 and 0.692 which is not significant. It suggests that the endothelial cell loss occurring on postoperative day 1,7 and 28 in NS III and NS IV cataract is not statistically significant.

The P value for endothelial cell loss on postoperative day 1, 7 and 28 in SICS group for NS III and NS IV cataract are 0.431, 0.570 and 0.107 which is not significant. It suggests that the endothelial cell loss occurring on postoperative day 1, 7 and 28 in NS III and NS IV cataract is not statistically significant.

The difference in endothelial cell loss between nuclear sclerosis grades (NS-III and NS-IV) within each surgical group is **not statistically significant**, suggesting that the severity of the cataract (in terms of nuclear sclerosis) does not have a major impact on the extent of endothelial cell loss in either procedure.

Table 14: Comparison of endothelial cell loss in Phacoemulsification surgery of various studies with our study

	Preoperative endothelial cell count	POD -1 ECL	POD-7 ECL	POD-28 ECL	POD – 42 ECL
Tejinder et al [9]	2502.70	205.24 (8.22%)	326.81 (12.96%)	418.36 (16.64%)	494.04 (19.53%)
Jagani et al [8]	2497.07	-	307.80(12.33%)	-	399.79 (15.93%)
Satyavani et al [12]	2575	266 (10.33%)	466 (18.09%)	-	651(25.28%)
Mohan et al [11]	2433.71	-	324.31(13.33%)	-	354.95(14.58%)
Present study	2507	213.32 (8.49%)	320.85 (12.79%)	416.19 (16.59%)	-

In the study, the endothelial cell loss was 213.32 cells/mm^2 (8.49%) on postoperative day 1 which is similar to study conducted by **Tejinder et al** where the endothelial cell loss on postoperative day 1 was 205.24 cells/mm^2 (8.22%) and in study **Satyavani et al** it was 266 cells/mm^2. (10.33%)

In our study, the endothelial cell loss was 320.85cells/mm^2 (12.79%) on postoperative day 7 which is similar to study conducted by **Tejinder et al** where the endothelial cell loss on postoperative day 7 was 326.81 cells/mm^2 (12.96%), in study by **Jagani et al it** was 307.80 (12.33%), in study by **Satyavani et al** it was 466 cells/mm^2 (18.09%) and in study by **Mohan et al** 324.31 cells/mm^2 (13.33%).

In our study, the endothelial cell loss was 416.19 cells/mm^2 (16.59%) on postoperative day 28 which is similar to study conducted by **Tejinder et al** where the endothelial cell loss on postoperative day 28 was 418.36 cells/mm^2 (16.64%).

Table 15: Comparison of endothelial cell loss in SICS of various studies with our study

Name of study	Preoperative endothelial cell count	POD -1 ECL	POD-7 ECL	POD-28 ECL	POD – 42 ECL
Tejinder et al	2476	165.81 (6.60%)	274.03 (10.95%)	359.16(14.41%)	427.51(17.17%)
Jagani et al	2547.67	-	270.86(10.63%)		385.22(15.12%)
Mohan et al	2486.82	-	314.61(12.56%)		345.71(13.90%)
Thakur et al [13]	2673.04	364.03(13.61%)	398.76(14.91)	423.27(15.83%)	-
Charel et al [14]	2689.65	-	256.37(9.53%)	301.67(11.21%)	-
Present study	2527.04	160.14(6.33%)	257.04 (10.17%)	360.56(14.26%)	-

In the study, the endothelial cell loss was 160.14 cells/mm^2 (6.33%) on postoperative day 1 which is similar to study conducted by **Tejinder et al** where the endothelial cell loss on postoperative day 1 was 165.81 cells/mm^2 (6.60%) and in study by **Thakur et al** it was 364.03 cells/mm^2 (13.61%).

In our study, the endothelial cell loss was 257.04cells/mm^2 (10.17%) on postoperative day 7 which is similar to study conducted by **Tejinder et al** where the endothelial cell loss on postoperative day 7 was 274.03 cells/mm^2 (10.95%), in study by **Jagani et al** it was 270.86 cells/mm^2 (10.63%), in study by **Thakur et al** it was 398.76 cells/mm^2(14.91%), in study by **Mohan et al** 314.61 cells/mm^2 (12.56%) and in study by **Charel et al** 256.37 cells/mm^2 (9.53%)

In our study, the endothelial cell loss was 360.56 cells/mm^2 (14.26%) on postoperative day 28 which is similar to study conducted by **Tejinder et al** where the endothelial cell loss on postoperative day 28 was 359.16 cells/mm^2 (14.41%), in study by **Charel et al** 301.67 cells/mm^2 (11.21%) and in study by **Thakur et al** 423.27 cells/mm^2 (15.83%).

Any operating surgeon has serious concerns about the endothelial cell loss that occurs during cataract surgery. In the Indian population, the average endothelial cell density is roughly 2527±337 cells/mm^2.

The endothelial cell density always decreases after cataract surgery because of cell loss. Endothelial cell density in cataract-operated corneas declines more quickly than in healthy, unoperated corneas. All of these investigations found that patients having phacoemulsification experienced a greater loss of endothelial cells than those undergoing small incision cataract surgeries. However, there has been no discernible statistical difference in the groups' rates of cell loss.

Our study's findings demonstrate the safety of both surgical methods for the corneal endothelium. To

estimate the safety of a surgical approach, any alteration in the corneal endothelium is a crucial metric of surgical stress. Despite the same surgical technique, several studies show varying endothelial cell losses. Variations in cataract grades, variations in the nucleus delivery method, variations in the irrigating solutions and Ocular Viscoelastic Devices (OVD) used and variations in inclusion and exclusion criteria could all contribute to this. Furthermore, endothelial cell death following cataract surgery may be caused by a variety of factors, including the amount of energy released during phacoemulsification, the duration, and interaction of the corneal endothelium with instruments, lens fragments, and IOL, as suggested by **Elvira et al**. [15]

According to studies, there are preoperative & intraoperative factors that affect the likelihood of endothelial cell loss following phacoemulsification. The risk of endothelial cell loss following phacoemulsification can be increased by various factors, including hard nucleus density, advanced age, prolonged phacoemulsification time, high ultrasonic energy, phacoemulsification approach, and large infusion volumes.

In a study comparing the cell loss in ECCE with phacoemulsification, Rupert et al. found that endothelial cells decreased by 10% in both groups. [16]

According to research by George et al., endothelial cell loss occurred following standard ECCE, MSICS, and phacoemulsification at rates of 4.72%, 4.21%, and 5.41%, respectively. Between the groups, there has been no statistically significant variation in cell loss. [17]

An Italian study examined the differences in endothelial cell loss among the corneal incisions made transparent and scleral tunnel incisions. This Italian study found that scleral tunnel incisions lost fewer endothelial cells than clear corneal incisions. This could be a result of the scleral tunnel incision being made farther posteriorly, which results in less endothelial damage both directly and indirectly. [18]Nonetheless, all of the patients in this study had clean corneal incisions and underwent phacoemulsification. At four weeks postoperatively, research by **Tao Jiang et al.** revealed endothelial cell loss of 289 cells/mm^2 (18.5%) and 259 cells/mm^2 (19%) in the Phacoemulsification and SICS groups. [19]

Overall, the study found that Phacoemulsification resulted in greater endothelial cell loss compared to SICS, with significant differences at all postoperative time points. Both techniques led to significant cell loss from preoperative values, but the difference between the techniques remained statistically significant.

Conclusion

The study compared corneal endothelial cell loss between Phacoemulsification and Small Incision Cataract Surgery (SICS) and found that Phacoemulsification resulted in greater endothelial cell loss than SICS at all postoperative points (Days 1, 7, and 28). The difference in endothelial cell loss was statistically significant, with Phacoemulsification causing more endothelial cell loss, particularly in patients with higher nuclear sclerosis (NS III and NS IV). The findings suggest that SICS, which leads to less endothelial cell loss, may be more suitable in resource-limited settings or for patients with higher risk of corneal endothelial damage. Both techniques are effective, but the choice of procedure should consider the patient's specific needs and the surgeon's expertise.

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Abbreviations:

WHO: World Health Organization

CSC: Cataract Surgical Coverage

VA: Visual Acquity

ECC: Endothelial cell count

SICS: Small Incision Cataract Surgery

NS: Nuclear Sclerosis

IOL: Intra Ocular Lens

HMMA: Hydroxymethylethacrylate

ECCE: Extra Capsular Cataract Extraction

ICCE: Intra Capsular Cataract Extraction

CV: Coefficient of Variation

CD: Cell Density

BSS: Basic Salt Solution

CCT: Central Corneal Thickness

POD: Post-Operative Day

ECL: Endothelial Cell Loss

OVD: Ocular Viscoelastic Device

RE: Right Eye

LE: Left Eye

LOCS: Lens Opacities Classification System