International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Endothelial Cell Count Changes at 1 Week and 6 Weeks After Small Incision Cataract Surgery (SICS)

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OPEN ACCESS

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Received: 13-03-2026
Accepted: 18-05-2026
Available online: 29-05-2026

ABSTRACT

Background: Small Incision Cataract Surgery (SICS) is the preferred technique in high-volume settings across India and the developing world. Corneal endothelial cell loss is a key measure of surgical trauma and long-term corneal health.
Aim: To evaluate corneal endothelial cell count changes at 1 week and 6 weeks following SICS using the irrigating vectis technique.
Methods: A prospective observational study of 50 eyes undergoing SICS for senile cataract was conducted at Ahalia Foundation Eye Hospital from January to November 2012. Endothelial cell density (ECD) was measured by non-contact specular microscopy (Konan NSP-7700) preoperatively and at 1 week and 6 weeks postoperatively.
Results: Mean preoperative ECD was 2689 ± 222 cells/mm². At 1 week, mean cell loss was 132 cells (4.92%). At 6 weeks, mean cell loss was 258 cells (9.61%) with a mean ECD of 2430 ± 284 cells/mm². The difference was statistically significant ($p < 0.05$).
Conclusion: SICS using the irrigating vectis technique causes an endothelial cell loss of approximately 9.59% at 6 weeks, which is clinically acceptable and comparable to published data for phacoemulsification, making SICS a safe and viable alternative in resource-limited settings.

Keywords*: SICS, Small Incision Cataract Surgery, Corneal Endothelium, Endothelial Cell Loss, Specular Microscopy, Irrigating Vectis.*

INTRODUCTION

Cataract remains the leading cause of reversible blindness worldwide, accounting for nearly half of all cases of visual impairment globally.[1] More than 90% of the visually impaired live in developing countries, where cost-effective, high-volume surgical strategies are essential.[2] In India alone, approximately five million cataract surgeries are performed each year, making the choice of surgical technique a matter of substantial public health importance.[3]

Small Incision Cataract Surgery (SICS), performed through a scleral tunnel incision, has emerged as the preferred technique in high-volume settings because it combines the benefits of extracapsular surgery with the advantages of self-sealing wound architecture: reduced astigmatism, rapid visual rehabilitation, machine independence and lower cost.[4,5] The irrigating vectis technique of nucleus delivery is widely favoured within SICS because of its relative simplicity and gentle handling of the anterior chamber.

The corneal endothelium, a non-regenerating monolayer of hexagonal cells, is responsible for maintaining corneal transparency through its pump-barrier function. Endothelial cell density (ECD) declines naturally with age from approximately 3000–3500 cells/mm² in young adults to 1500–2000 cells/mm² in the elderly.[6] Any intraocular surgical procedure causes further, irreversible cell loss. When ECD falls below 400–500 cells/mm², the functional reserve is insufficient to maintain corneal deturgescence, resulting in bullous keratopathy.[7]

Specular microscopy, introduced by Maurice in 1968 and developed for clinical use by Laing in 1975, allows non-invasive quantification of ECD and morphological parameters (pleomorphism, polymegathism) both pre- and postoperatively.[8] Multiple studies have evaluated endothelial cell loss after SICS, but reported figures vary widely owing to differences in nucleus delivery technique, cataract grade, and inclusion criteria.[9,10]

The present study was designed to prospectively quantify endothelial cell changes at two postoperative time-points, 1 week and 6 weeks, following SICS performed exclusively by the irrigating vectis technique, in a defined cohort of senile cataract patients with preoperatively normal endothelia.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective observational study conducted at Ahalia Foundation Eye Hospital, Palakkad, Kerala - a JCI-accredited tertiary eye care centre. Patients were recruited consecutively from the outpatient department and surgical camps from January 2012 to November 2012. The study was conducted in accordance with the Declaration of Helsinki and institutional ethical standards; all participants provided written informed consent.

Inclusion and Exclusion Criteria

Patients aged 40 years and above undergoing SICS for senile cataract with a morphologically normal corneal endothelium on specular microscopy were enrolled. Eyes with corneal pathology, pseudoexfoliation, diabetes mellitus, uveitis, glaucoma, vitreoretinal disease, prior intraocular surgery, nuclear sclerosis grade 4 or above (LOCS III), traumatic cataract, or any intraoperative complication such as posterior capsule rent or vitreous loss were excluded.

Surgical Technique

All surgeries were performed by a single experienced surgeon. After peribulbar anaesthesia (5 mL of 2% lidocaine hydrochloride with 1:20,000 adrenaline), a fornix-based conjunctival flap was fashioned at the superior limbus. A 6 mm frown scleral incision was placed 1.5 mm posterior to the limbus; a sclerocorneal tunnel was created with a stainless-steel crescent blade. A side-port was made at 3 or 9 o'clock based on surgeon preference. The anterior chamber was filled with HPMC 2%, and a continuous curvilinear capsulorrhexis (CCC) was created with a 26 G bent needle. An anterior chamber entry was made with a 3.2 mm keratome and extended with an extension blade. Hydrodissection was performed with Ringer's Lactate. After nuclear rotation and delivery into the anterior chamber using a Sinskey hook with OVD support, the nucleus was removed by the irrigating vectis technique. Cortical clean-up was accomplished with a coaxial irrigation-aspiration cannula. A PMMA posterior chamber IOL was implanted in the capsular bag. OVD was meticulously aspirated, and a subconjunctival injection of gentamicin 10 mg and dexamethasone 2 mg was administered.

Endothelial Cell Assessment

Endothelial cell density (cells/mm²) was measured with a Konan Non-Con ROBO Specular Microscope X (NSP-7700) preoperatively and at 1 week and 6 weeks postoperatively. An average of five readings was taken at each visit; the automated cell-counting algorithm supplied by the manufacturer's software was used as the primary analysis method. A variable-frame (manual) count of 50 cells was additionally performed preoperatively and at 6 weeks to corroborate automated findings. Percentage endothelial cell loss was calculated as: [(Preoperative ECD − Postoperative ECD) / Preoperative ECD] × 100.

Statistical Analysis

Data are presented as mean ± standard deviation (SD). The paired Student's t-test was used to compare mean ECD between preoperative baseline and each postoperative time-point. A p-value < 0.05 was considered statistically significant. All analyses were performed using standard statistical software.

RESULTS

Demographic Characteristics

A total of 50 eyes of 50 patients were studied. The mean age was 64.5 years (range 55–75 years). There were 18 males (36%) and 32 females (64%). The majority of patients (21 eyes, 42%) were in the 61–70-year age group, reflecting the peak incidence of senile cataract in this population. Demographic data are summarised in Table 1.

Parameter	Category	n (%)
Age group (years)	< 50	0 (0%)
	51 – 60	19 (38%)
	61 – 70	21 (42%)
	> 70	10 (20%)
Mean age (years)	64.5	—
Sex	Male	18 (36%)
	Female	32 (64%)
Cataract type (NS only)	Nuclear Sclerosis	21 (42%)

	PSC only	6 (12%)
	Mixed / CC	23 (46%)
Table 1. Demographic Profile of Study Patients (SICS Group, n = 50)		
NS = Nuclear Sclerosis; PSC = Posterior Subcapsular Cataract; CC = Cortical Cataract		

Endothelial Cell Density: Summary Statistics

The mean preoperative ECD was 2688.8 ± 222.2 cells/mm². At 1 week postoperatively, mean ECD was 2556.6 cells/mm², representing a mean loss of 132.2 cells (4.92%). At 6 weeks, mean ECD was 2430.5 ± 283.8 cells/mm² — a mean loss of 258.4 cells (9.61%) from baseline. Summary statistics are presented in Table 2.

Parameter	Preoperative	1 Week Post-op	6 Weeks Post-op
Mean ECD (cells/mm²)	2688.8	2556.6	2430.5
SD (cells/mm²)	222.2	242.2	283.8
Mean cell loss (cells)	—	132.2	258.4
% cell loss	—	4.92%	9.61%
p-value (vs preop)	—	< 0.05*	< 0.05*
Table 2. Mean Endothelial Cell Density (ECD) at Preoperative, 1-Week, and 6-Week Visits (SICS, n = 50)			
**Paired Student's t-test. ECD = Endothelial Cell Density; SD = Standard Deviation*			

Percentage Cell Loss by Time Point

The mean percentage endothelial cell loss at 1 week was 4.92%, increasing to 9.61% at 6 weeks. This pattern is consistent with an early post-surgical inflammatory phase followed by progressive cell loss and remodelling during the first 6 weeks. Table 3 presents percentage cell loss data across both time-points.

Time Point	Mean Cell Loss (cells/mm²)	Mean % Cell Loss
1 Week	132.2	4.92%
6 Weeks	258.4	9.61%
Table 3. Mean Percentage Endothelial Cell Loss at 1 Week and 6 Weeks Post-SICS		

Individual Patient Data

Table 4 presents the complete individual patient data for all 50 eyes, including preoperative ECD, 1-week and 6-week postoperative ECD, and cataract morphology.

Sl. No.	Patient	Age	Sex	Pre-op ECD	1-Wk ECD	6-Wk ECD	Cataract
1	Patient 01	58	F	2733	2705	2700	NS2
2	Patient 02	55	M	2543	2500	2462	NS3
3	Patient 03	71	F	2842	2670	2476	NS2PSC
4	Patient 04	56	F	2803	2766	2635	NS2
5	Patient 05	62	F	2823	2766	2698	PSC
6	Patient 06	58	M	2991	2852	2447	CCNS2
7	Patient 07	70	M	2750	2500	2314	NS2
8	Patient 08	72	F	2673	2398	2056	NS2PSC
9	Patient 09	66	F	2491	2376	2345	CCNS3
10	Patient 10	62	F	2557	2456	2373	PSC
11	Patient 11	67	F	2662	2427	2319	NS2
12	Patient 12	65	M	2432	2376	2300	NS3PSC
13	Patient 13	71	M	2598	2480	2405	CCNS2
14	Patient 14	55	M	2278	2262	2230	NS3
15	Patient 15	66	F	2868	2467	2280	PSC
16	Patient 16	70	F	3063	3000	2999	CCNS2PSC
17	Patient 17	60	F	2891	2667	2465	NS1PSC
18	Patient 18	75	F	2423	2489	2137	PSC
19	Patient 19	58	M	2868	2645	2577	NS2PSC
20	Patient 20	63	F	2824	2789	2717	CCNS1
21	Patient 21	55	F	3208	3190	3145	NS3
22	Patient 22	69	F	2924	2857	2761	NS2
23	Patient 23	68	F	2712	2700	2699	CCPSC
24	Patient 24	62	F	2703	2687	2584	NS1PSC
25	Patient 25	68	F	2570	2395	2289	PSC
26	Patient 26	60	F	2693	2656	2555	NS3

27	Patient 27	55	F	2913	2879	2678	NS3
28	Patient 28	68	M	2820	2513	2356	CCNS2
29	Patient 29	67	F	2065	1897	1676	NS1PSC
30	Patient 30	57	M	2796	2561	2397	NS3
31	Patient 31	75	M	2884	2803	2752	NS2
32	Patient 32	64	F	2448	2221	2068	NS2PSC
33	Patient 33	65	M	2909	2563	2118	NS1PSC
34	Patient 34	72	M	2732	2580	2378	NS3
35	Patient 35	75	F	2564	2465	2374	NS2
36	Patient 36	72	F	2463	2318	2290	NS2
37	Patient 37	60	F	2538	2407	2396	NS1PSC
38	Patient 38	65	M	2646	2542	2488	NS3
39	Patient 39	58	F	2196	2150	2065	NS3PSC
40	Patient 40	60	M	2949	2783	2647	PSC
41	Patient 41	60	F	2623	2565	2510	NS2
42	Patient 42	75	F	2616	2599	2542	NS2PSC
43	Patient 43	70	M	2783	2658	2516	CCNS3
44	Patient 44	68	F	2955	2765	2679	NS3
45	Patient 45	75	M	2640	2000	1586	NS2
46	Patient 46	55	F	2342	2300	2238	CCNS2
47	Patient 47	60	F	2653	2584	2365	CCNS3
48	Patient 48	60	M	2541	2250	2151	NS2PSC
49	Patient 49	60	F	2625	2562	2496	NS3
50	Patient 50	68	M	2817	2789	2789	NS2
	MEAN	**64.5**		**2688.8**	**2556.6**	**2430.5**	

Table 4. Individual Patient Endothelial Cell Counts (SICS, Automated Method)

ECD = Endothelial Cell Density (cells/mm²). NS = Nuclear Sclerosis; PSC = Posterior Subcapsular Cataract; CC = Cortical Cataract

DISCUSSION

The present study documents a mean endothelial cell loss of 4.92% at 1 week and 9.61% at 6 weeks following SICS using the irrigating vectis technique. These figures are consistent with the range of 4–17% loss reported in the literature for SICS and indicate a clinically acceptable degree of endothelial trauma.[11]

The pattern of loss observed - with the bulk of cell death occurring within the first week and continued, though slower, loss thereafter - is consistent with the natural history of endothelial injury described by Schultz et al.[12] Early loss is attributable to direct mechanical trauma from intraocular instrumentation, brief nucleus–endothelium proximity during anterior-chamber manoeuvres, and the acute inflammatory response. Continued cell loss between 1 and 6 weeks may reflect ongoing wound healing, the effects of prolonged postoperative inflammation, or the lag in specular microscopic detection of injured but not immediately lost cells.

Studies employing different nucleus delivery strategies for SICS have reported correspondingly different levels of endothelial loss. Thakur et al. found a loss of 15.83% at 1 month using the same irrigating vectis technique, but included mature and hard cataracts in their series.9 Wright and Chawla reported a 16% loss using the anterior chamber (AC) maintainer technique.[13] Vajpayee et al. recorded 17.66% at 3 months with the phacofracture approach, and Gogate et al. documented 15.3% at 6 weeks using visco-expression.[10,14] The lower loss in the present study (9.59% at 6 weeks) is attributable to the exclusion of grade 4 and above cataracts and to the inherent gentleness of the irrigating vectis, which limits the duration of nuclear manipulation within the anterior chamber.

George et al. and Sasikumar et al. reported even lower losses of 6.07% and 4.21% respectively at comparable time-points, both series being restricted to early immature cataracts (NS grades 1–3).[11,15] The inclusion in the current study of PSC and combined morphologies (NS+PSC, cortical cataract) accounts for the modestly higher mean loss. Harder nuclei require greater intraocular manipulation, generate more mechanical shear at the endothelium, and increase the duration of AC irrigation.

The incremental increase in cell loss between week 1 (4.91%) and week 6 (9.59%) underscores the importance of the 6-week time-point as the minimum follow-up for accurate assessment. Studies with only 1-week follow-up will systematically underestimate the definitive endothelial impact of SICS. The gradual decrease in the rate of loss after 6 weeks, as documented in longer-term studies, suggests that the figures reported here represent near-maximal early loss attributable to the procedure itself.[8]

Limitations of this study include a sample size of 50 eyes, a relatively short maximum follow-up of 6 weeks, and the absence of morphometric data (coefficient of variation, percentage hexagonality) beyond cell density. A larger study with longer follow-up, including 3- and 12-month assessments and morphometric indices, would provide a more complete characterisation of the endothelial response to SICS.

CONCLUSIONS

SICS using the irrigating vectis technique results in a mean endothelial cell loss of 4.92% at 1 week and 9.61% at 6 weeks postoperatively in patients with senile cataract of up to LOCS III grade 3. This degree of endothelial trauma is clinically acceptable and falls within published ranges for phacoemulsification. The irrigating vectis technique appears to be among the least traumatic nucleus delivery methods for SICS and should be favoured in settings where phacoemulsification is unavailable or cost-prohibitive. A larger, longer-term study incorporating morphometric endothelial parameters is warranted to confirm these findings.

Acknowledgement

I would like to express my sincere gratitude to Dr. Satyajit M V for his invaluable guidance throughout this study. His insightful feedback and expertise were instrumental in shaping this research.

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