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Study Of Central Corneal Thickness (CCT) And Endothelial Cell Count Before and After Small Incision Cataract Surgery (SICS).

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ABSTRACT:
Introduction: Manual small incision cataract surgery (SICS) is widely practiced, serving as a fundamental aspect of ophthalmology training in countries like India. This study aims to investigate the changes in corneal thickness and endothelial cell count (ECC) following manual SICS and to identify preventive measures that can be implemented in a quaternary care research institute to prevent such changes.
Methodology: This prospective observational cohort study was conducted over one year on 35 patients after considering the inclusion and exclusion criteria. Snellen's visual acuity chart, slit lamp, rebound tonometer, optical pachymeter, and keratometer and IOL calculator for keratometry and intraocular lens power calculation using the SRK formula were used to collect data and were entered in Excel and analyzed using SPSS version 2.0
Results: Postoperatively, central corneal thickness (CCT) increased significantly from a mean of 517.31 µm preoperatively to 559.91 µm on Day 1, then stabilized at approximately 516.86 µm by Day 30 ($p < 0.001$). ECC exhibited a progressive decline from 2582 cells/mm² preoperatively to 2067.6 cells/mm² by Day 30 ($p < 0.0001$). Age and gender showed no significant effect on CCT or ECC changes, suggesting these factors do not independently influence surgical outcomes.
Conclusion: SICS results in transient CCT changes and a persistent reduction in ECC. These findings underline the need to closely monitor endothelial cell density following surgery.
Keywords: Cataract Surgery, Central corneal thickness, Endothelial Cell Count, Small incision cataract surgery

I. INTRODUCTION

A cataract is a clouding or opacification of the normally clear lens of the eye or its capsule that obscures the passage of light through the lens to the retina of the eye.[1] Cataracts are one of the main reasons for blindness. It can be corrected with refractive glasses during its earlier stages. However, if the cataract mature and affect the routine activities, surgical management would be the treatment of choice.[2]According to the national blindness and visual impairment (NPCB and VI) survey 2015–2019, cataract contributes to 66.2% of blindness and 71.2% of visual impairment in the population above 50 years in India. The increase in cataract-related blindness may be due to the rise in life expectancy, environmental factors, and challenges in accessing surgical facilities.[3]

Due to the changing trends in cataract surgery outcomes, surgical techniques have evolved rapidly. Recent advances in cataract surgery have introduced new complications, such as mechanical or toxic endothelium injury. Moderate endothelium damage during surgery may result in a transient increase in corneal thickness.

The loss or harm of endothelial cells can lead to an increase in corneal thickness, which can lead to corneal decompensation and vision loss. To prevent these issues, it is crucial to give close attention during cataract surgery and in the postoperative period.[4] Maintenance of corneal structure is crucial for the physiological functions of the tissue in refraction and transparency. A smooth and uninterrupted epithelium, a transparent stroma, and a functioning endothelium are essential for clear vision.

Manual small incision cataract surgery (MSICS) is a widely practiced technique with various aspects being examined closely. Recent studies have shown that MSICS is relatively safe and provides satisfactory visual outcomes, although preoperative risk factors can significantly increase complication rates.[5] From an economic perspective, MSICS has been found to be more cost-effective compared to phacoemulsification, with lower direct costs, making it a favorable option for cataract removal.[6] Additionally, MSICS is a cornerstone in Indian ophthalmology training programs and is extensively utilized in high-volume settings due to its efficiency, cost-effectiveness, and positive outcomes. This study aims to determine the change in corneal thickness and endothelial cell count after small incision cataract surgery and the outcome and to find the preventive measures that may be implemented to prevent the same in a quaternary care research institute.

II. METHODOLOGY:

This prospective observational cohort study was conducted on patients who underwent SICS as inpatients from 1st of August 2022 to 30th June 2023 at A. J. Institute of Medical Science and Research Institute, Mangalore, Karnataka, India. After being approved by the ethics committee, the study included 35 patients based on their inclusion and exclusion criteria. Informed consent was obtained from the patient before they were included in the study. A pre-structured and pretested proforma was used to gather information. Medical records and case sheets were referred whenever necessary to collect additional information.

Inclusion Criteria: Patients undergoing small incision cataract surgery with age above 40 years and patients who were willing to undergo follow-up for six weeks.

Exclusion Criteria: Any preexisting ocular disease like Ocular allergies Pterygium, glaucoma, previous ocular surgery, any intra operative complications during this surgery, insertion of anterior chamber intraocular lens, auto-immune disorders, diabetes mellitus, any deviation in the operative steps other standard, postoperative trauma, postoperative infection.

All patients were admitted one day before the surgery. After obtaining informed consent, a detailed history including patient's age, sex, occupation, address, presenting symptoms, duration, progression, and associated conditions were recorded. General systemic examination was conducted to rule out any systemic illness and relevant investigations were conducted to rule out the same. This was followed by a detailed ocular examination, in which materials used were as follows:

1. Snellens visual acuity chart for testing vision and preoperative refraction was performed.
2. Slit lamp for detailed anterior segment examination and grading of cataract.
3. Posterior segment was evaluated using both direct and indirect ophthalmoscope.
4. Applanation tonometer for measuring intraocular pressure.
5. Optical pachymeter for measuring the CCT and specular microscope for ECC.
6. Optical biometer for keratometry and for IOL power calculation using SRK formula.

Statistical Analysis: Descriptive statistics summarized baseline characteristics, with qualitative variables presented as counts and percentages, and quantitative variables as mean and standard deviation. Data normality was assessed using the Kolmogorov-Smirnov test. Repeated measures ANOVA compared CCT and ECC scores across time points, with Bonferroni Post Hoc Test for paired comparisons. Linear regression analyzed age and gender effects on CCT and ECC. A 95% confidence interval and 5% significance level were maintained. Data was entered into Microsoft Excel and analyzed using SPSS version 20.0.

III. RESULTS

To assess the effects of small incision cataract surgery (SICS) on central corneal thickness (CCT) and endothelial cell count (ECC). We evaluated postoperative changes in CCT and ECC, identified factors influencing these changes, and explored strategies to minimize complications. The findings are organized into three parts: baseline characteristics of the study population, postoperative changes in CCT and ECC at various intervals, and the influence of age and gender on these changes.

Baseline characteristics of the study population

The study population consisted of 35 participants, with a mean age of 59.43 years (SD ±5.56), ranging from 48 to 68 years. A notable portion of the cohort (60%) was aged between 58 and 68 years, indicating that majority of patients undergoing small incision cataract surgery (SICS) in the older age group. Gender distribution was relatively balanced, with 57.1% male and 42.9% female participants. This demographic profile provides essential context for exploring potential age- and gender-related differences in postoperative changes in central corneal thickness (CCT) and endothelial cell count (ECC), which are critical to understanding impact of SICS on corneal health (Table 1).

Table 1: Distribution of age among the study population

Variables	Counts	Percentage
Age in years		
Range	48–68	
Mean±SD	59.43±5.56	
48-58	14	40%

58-68	21	60%
Total	35	100%
Gender		
Male	20	57.1%
Female	15	42.9%
Total	35	100%

Assessment of Central Corneal Thickness (CCT) and Endothelial Cell Count (ECC) the study population

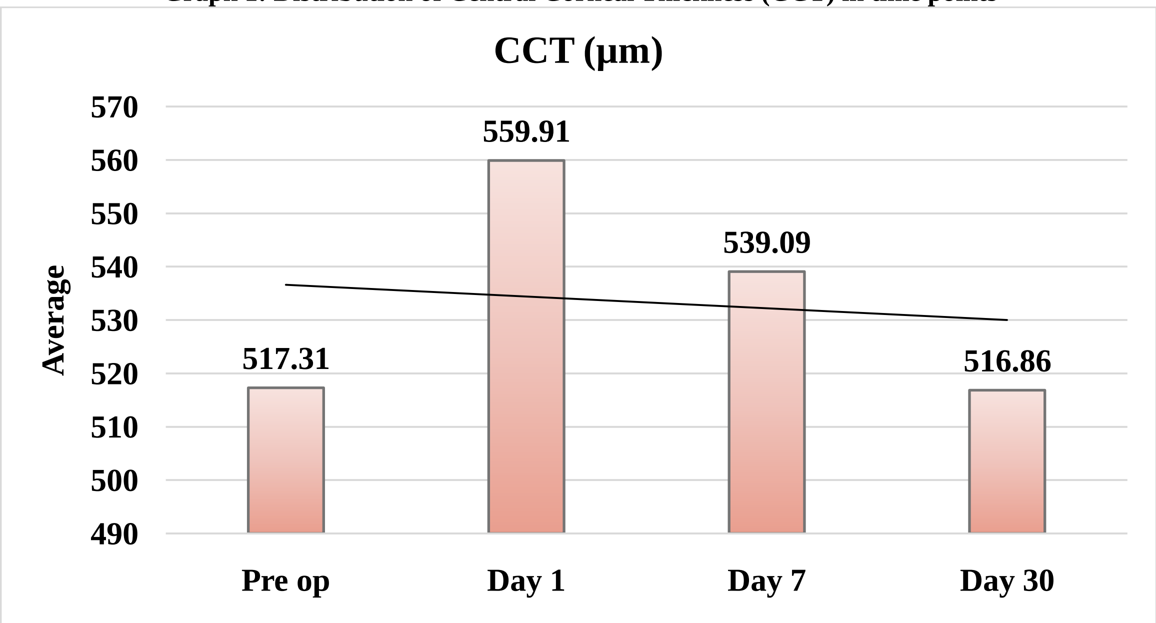
The assessment of Central Corneal Thickness (CCT) and Endothelial Cell Count (ECC) following small incision cataract surgery (SICS) revealed significant postoperative changes. CCT showed a marked increase from preoperative values (mean 517.31 ± 16.62 µm) to Day 1 post-surgery (mean 559.91 ± 26.23 µm), followed by a gradual reduction over time, with near stabilization by Day 30 (mean 516.86 ± 16.43 µm) (Graph 1). Repeated measures ANOVA confirmed a statistically significant change in CCT across time points ($F = 75.34$, $p < 0.001$), underscoring the early thickening post-surgery, followed by recovery. Pairwise comparisons further highlighted significant differences between each postoperative time point, emphasizing the dynamic nature of corneal healing (Table 2).

Table 2: Distribution and comparison of Central Corneal Thickness (CCT) in time points

CCT	Range (µm)	Mean±SD	F value (Sig.)
Pre op	493–550	517.31±16.62	75.34 (<0.001)*
Day 1	513–598	559.91±26.23	
Day 7	507–576	539.09±20.51	
Day 30	485–545	516.86±16.43	

***Repeated Measures ANOVA, P<0.05 shows significance**

Graph 1: Distribution of Central Corneal Thickness (CCT) in time points



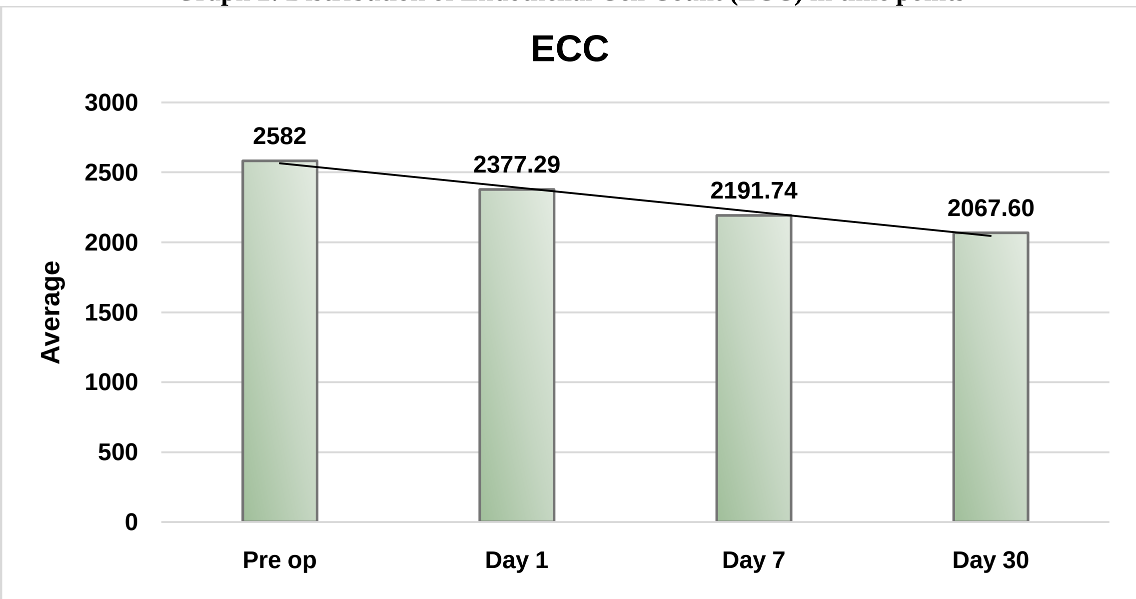
Similarly, ECC demonstrated a progressive decline post-surgery. The mean preoperative ECC of 2582 ± 164.99 cells/mm² decreased significantly to 2377.29 ± 165.59 cells/mm² on Day 1, 2191.74 ± 151.53 cells/mm² on Day 7, and 2067.6 ± 107.72 cells/mm² by Day 30 (Graph 2). This decline was highly significant (F = 134.04, p < 0.0001), with pairwise comparisons revealing notable differences between each time point. These results suggest that SICS has a pronounced impact on endothelial cell density, which may influence long-term corneal health and visual recovery following surgery (Table 3).

Table 3: Distribution and comparison of Endothelial Cell Count (ECC) in time points

ECC	Range	Mean±SD	F value (Sig.)
Pre op	2211–2920	2582±164.99	134.04 (<0.0001)*
Day 1	2103–2740	2377.29±165.59	
Day 7	2000–2560	2191.74±151.53	
Day 30	1909–2318	2067.6±107.72	

Repeated Measures ANOVA, P<0.05 shows significance

Graph 2: Distribution of Endothelial Cell Count (ECC) in time points



Assessment of effect of age and gender in Central Corneal Thickness (CCT) and Endothelial Cell Count (ECC)

This section explores the influence of age and gender on central corneal thickness (CCT) and endothelial cell count (ECC) among participants undergoing small incision cataract surgery (SICS). We examined whether age-related changes in corneal structure and function, as well as gender disparities, had any significant impact on surgical outcomes. Through linear regression analysis, we aimed to identify any correlations or differences that could inform personalized treatment approaches and optimize surgical outcomes.

Table 4 presents the regression analysis results for the impact of age and gender on CCT at various time points (Preoperative, Day 1, Day 7, Day 30) following SICS. The analysis reveals no statistically significant effect of age or gender on CCT across all time points, suggesting that these demographic factors do not independently influence postoperative CCT outcomes in this cohort.

Table 4: Effect of Age and Gender on Central Corneal Thickness (CCT) at Different Time Points

CCT		B	Std. Error	t	Sig.*	95% Confidence Interval Lower Bound	Upper Bound
CCT-Preop	Intercept	515.41	5.44	94.76	0.000	504.33	526.49
	Age	-0.89	6.03	-0.15	0.884	-13.18	11.39
	Gender	3.96	5.97	0.66	0.512	-8.20	16.12
CCT-Day 1	Intercept	559.32	8.65	64.64	0.000	541.70	576.95
	Age	-0.48	9.59	-0.05	0.960	-20.03	19.06
	Gender	1.37	9.50	0.14	0.886	-17.98	20.72
CCT-Day 7	Intercept	537.08	6.64	80.94	0.000	523.56	550.59
	Age	-3.89	7.36	-0.53	0.600	-18.88	11.09
	Gender	6.24	7.28	0.86	0.398	-8.59	21.08
CCT-Day 30	Intercept	513.80	5.26	97.64	0.000	503.08	524.52
	Age	-2.38	5.83	-0.41	0.686	-14.26	9.51
	Gender	7.01	5.78	1.21	0.234	-4.75	18.78

***Linear Regression Analysis (p<0.05 shows significance)**

Table 5 presents regression analysis results for the influence of age and gender on ECC at various postoperative time points. Similar to CCT, neither age nor gender significantly impacted ECC, indicating that these demographic variables did not independently affect endothelial cell count following SICS in this cohort.

Table 5: Effect of Age and Gender on Endothelial Cell Count (ECC) at Different Time Points

ECC		B	Std. Error	t	Sig.*	95% Confidence Interval Lower Bound	Upper Bound
ECC-Preop	Intercept	2544.0	50.5	50.4	0.000	2441.2	2646.8
	Age	-50.4	56.0	-0.9	0.374	-164.4	63.6
	Gender	101.8	55.4	1.8	0.076	-11.1	214.6
ECC-Day 1	Intercept	2359.7	52.8	44.7	0.000	2252.2	2467.2
	Age	-45.7	58.5	-0.8	0.440	-164.9	73.5
	Gender	62.9	57.9	1.1	0.286	-55.1	180.9
ECC-Day 7	Intercept	2214.2	49.2	45.0	0.000	2114.0	2314.4
	Age	-55.5	54.5	-1.0	0.316	-166.6	55.6
	Gender	-0.5	54.0	0.0	0.993	-110.4	109.5
ECC-Day 30	Intercept	2080.9	35.4	58.7	0.000	2008.7	2153.1
	Age	-12.9	39.3	-0.3	0.746	-92.9	67.2
	Gender	-14.3	38.9	-0.4	0.715	-93.6	64.9

***Linear Regression Analysis (p<0.05 shows significance)**

IV. DISCUSSION:

This prospective observational cohort study was conducted on 35 participants at A. J. Institute of Medical Sciences and Research Institute, Mangalore. The participants were between the age group of 40 to 70 years. The patients with preexisting ocular diseases, previous ocular surgery, intraoperative complications during SICS or any deviation in the operative steps other than standard, insertion of anterior chamber ocular lens, autoimmune disorders, diabetes mellitus, and failure to follow up were completely excluded to know the impact of SICS on CCT and ECC.

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The study successfully assessed changes in both central corneal thickness and endothelial cell count following SICS. Analysis of CCT revealed a significant increase in immediate post-surgery, which gradually returned to near preoperative levels by Day 30. This temporal pattern indicates an initial thickening effect of the surgical procedure on the cornea, followed by a stabilization phase during the early recovery period. Similarly, ECC exhibited a notable decline postoperatively across all time points assessed (Day 1, Day 7, and Day 30), suggesting a progressive decrease in endothelial cell density after surgery.

KongsapPipat did a study to assess CCT and endothelial cell loss after manual SICS and phacoemulsification in patients with white cataract and reported that in both group CCT increased after surgery.[7]Their study showed that the CCT value returned to the preoperative level following one month postoperatively.

Aribaba et al.reported that in their study population, 59% were males and 41% were females. Considering the age of their study group, 5% were less than 40 years, and the mean age of the study group was 63.3 ± 8 years.[8]In our study, 57.1% of the participants were male and 42.9% were female with a mean age of 59.43 ± 5.56 years. Pant et al. reported that the prevalence of cataract was higher in females compared to males in India.[9] Most of the participants were males in this study and may be due to the fact that women still have poor access to eye health services often with their influencing factors such as economic, geographic, cultural, social, and sex issues as reported by Mganga et al.[10]

Aribaba et al. had measured CCT values six times- preoperatively, postoperative day 1, 2 weeks postop, 4 weeks postop, 8 weeks postop and 12 weeks postop.[8] In this study CCT values were measured four times- preoperatively, postop day 1, postop day 7, and postop day 30. These initial measurements were used as the baseline value for assessing postoperative changes in CCT. Immediate postoperative day 1 showed increase in CCT, which could be due to corneal swelling or edema due to endothelial cell loss following SICS.[11] However, early recovery trends were observed from Day 7 and there was a reduction in the CCT value possibly due to reduction in edema. By day 30, we assessed the long-term recovery of CCT, and the values returned to near preoperative value indicating the ability of the cornea to regain its normal thickness. This may be because the postoperative care following surgery was successful in minimizing long-term corneal edema.

Kumar et alreported that CCT increased postoperatively and attained preoperative value by the sixth week.[11]They measured the CCT values on postoperative days one, third, and six weeks. Aribaba et al. reported that the mean baseline CCT increased after 24 hours of cataract surgery, gradually decreased by two weeks, and attained the baseline value by 12 weeks.[8]However, we measured the CCT values on postoperative days 1, 7, and 30. We found that central corneal thickness reduced gradually and attained a near preoperative value by Day 30, which is much earlier compared to the time specified by Kumar et al and Aribaba et al.[8,11]

Kumar et al reported that there was a decrease in endothelial cell density of 0.21% after SICS at day 1 with a statistically significant difference (P < 0.01) and 7.07% at 3rd week with a statistically significant difference (P < 0.01).[11]At 6th week, the endothelial cell count reduced to 10.81%. There was a gradual decrease in the ECC after SICS. Our study also showed similar results where the ECC gradually decreased from Day 1 to Day 30. Initial decrease on day 1 shows the impact of surgical procedure on corneal endothelium which may be due to surgical trauma and mechanical stress during the procedure.[12]The gradual decrease in ECC indicates that patients undergoing SICS should be closely monitored for endothelial health, particularly in the first few weeks postoperatively. These findings comprehensively illustrate the dynamic alterations in corneal structure induced by SICS, fulfilling the objective of quantifying changes in CCT and ECC throughout the postoperative period.Interventions to protect the corneal endothelium, such as using viscoelastic agents during surgery and administering anti-inflammatory medications postoperatively, may be beneficial.[13]Ventura et al. conducted a study to assess the impact of moderate reductions in endothelial cell count on corneal stroma thickness, focusing on patients who experienced such reductions due to cataract surgery.[4] Measurements of central corneal thickness and endothelial cell counts were taken one day before surgery, one day after, at three months, one year, and three years post-surgery. Statistical analysis revealed that despite significant corneal swelling immediately after surgery, preoperative thickness values were restored at three and twelve months, even with endothelial cell loss.[4]

Our study investigated potential factors contributing to changes in CCT and ECC following SICS, focusing on age and gender as key variables. Regression analyses indicated that neither age nor gender independently influenced CCT or ECC outcomes at any time points examined. This suggests that within the study population, variations in age or gender did not statistically affect the observed changes in corneal parameters post-SICS.

Goel et al reviewed the complications of manual small incision cataract surgery and reported that MSICS is a widely used cataract extraction method that involves the removal of the lens through a small incision in the eye under local anesthesia. This method is commonly employed for high-volume and charity surgeries. Several studies have compared MSICS and PE, showing comparable complication rates. When performing MSICS, it is important to suture any incisions with poor integrity to minimize the risk of SIA and endophthalmitis. The use of ophthalmic viscosurgical devices (OVD) during nuclear manipulation helps prevent endothelial damage and iritis. It is not recommended to use nuclear delivery with extensive intracameral instrumentation in cases where the cornea is compromised. Inferior iridodialysis is a unique complication associated with techniques that use microvectis. Zonular dialysis can occur when the nucleus is manipulated aggressively through a small capsulorhexis. To achieve good postoperative outcomes, it is important to construct an appropriately sized triplanarsclero-corneal tunnel, perform an adequately sized capsulorhexis, and use gentle intracameral maneuvers under OVD cover.[14]

The primary strength of our study lies in the careful selection of participants who underwent small incision cataract surgery. We carefully excluded individuals with preexisting ocular diseases, prior ocular surgeries, intraoperative complications during SICS, or deviations from standard operative procedures. Moreover, we also excluded patients with anterior chamber ocular lens insertions, autoimmune disorders, and diabetes mellitus. This selection process allowed us to create a homogenous study population, enabling us to concentrate solely on the influence of SICS on central corneal thickness and endothelial cell count.

This study was conducted at a single center and involved a relatively small sample size of 35 patients, which limits the generalizability of the results. A larger, multicenter trial with a more intensive randomized design would provide more robust and generalizable findings. Furthermore, our research did not incorporate best-corrected visual acuity as a variable, which could have offered additional insights into the functional results following SICS.

V. CONCLUSION:

Our investigation into potential factors contributing to changes in CCT and ECC focused on age and gender as key variables. However, neither age nor gender independently influenced CCT or ECC outcomes at any time points examined. This suggests that within the study population, variations in age or gender did not statistically affect the observed changes in corneal parameters post-SICS. The transient nature of CCT changes and the persistent reduction in ECC after SICS are both highlighted by our study. These results underscore the significance of closely monitoring endothelial cell density after surgery. Future research should involve larger, multicenter trials and include best-corrected visual acuity as a variable to provide more comprehensive insights into the functional outcomes of SICS.

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