



## Evaluation of the Effect of Various Intra Operative Surgical Complications on Central Corneal Endothelial Cell Density and Central Corneal Thickness- A Prospective Study

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### Abstract

**Purpose:** To evaluate the effect of various intra operative surgical complications on Central Corneal Endothelial Cell Density and Central Corneal Thickness

**Methods:** A prospective study comprising of 222 patients who underwent small incision cataract surgery, which were divided into three groups.

G1 -Irrigating vectis technique-73 patients

G2-Sandwich technique-75 patients

G3 -Visco expression technique-74 patients.

All patients underwent complete ophthalmic examination and biometry followed by measurement of central corneal thickness, specular microscopy (endothelial images) was performed at baseline (preoperative) and postoperatively at 1week, 2 weeks, 1 month and 3 months.

**Results:** In our study, out of 222 patients, 180 patients had uneventful and 42 patients had complicated surgeries. In that 42 complicated surgeries,

-11 patients had instrumental trauma (26.2%) which caused 25.2% endothelial cell loss (p value 0.001) and 5% increase in CCT.

-14 patients had Iris prolapse (33.3%) which caused 19.1% cell loss (p value 0.001) and 0.9% increase in CCT

-7 patients had IOL Contact (16.7%) which caused 13.1% cell loss (p value 0.003) and 1.9% increase in CCT

-9 patients had vitreous loss (21.4%) which caused 11.5% cell loss (p value 0.039) and 0.9% increase in CCT and 1 patient had Iris posterior capsular rent (2.4%) which caused 11.3% cell loss and 0.9% increase in CCT at 3 months post operatively.

In all 42 complicated surgeries, average 10.6% cell loss and 5.8% increase in CCT was found.

In all 180 uneventful surgeries, average 9.5% cell loss and 3.48% increase in CCT was found.

**Conclusion:** Percentage of endothelial cell loss and increase in central corneal thickness was more in complicated surgeries, than uneventful surgeries.

## Introduction

Cataract is opacity of natural, crystalline lens of the eye and remains the most frequent cause of blindness in the world today<sup>1</sup>. World Health Organisation estimates that 50% of persons currently blind worldwide are blind from cataract. Because of increasing population and the increasing life expectancy, the number of older people will double from 606 million in 2000 to 1.2 billion in 2025<sup>2</sup>.

In the last couples of decades, the choice of cataract surgery has shifted to mainly suture less small incision cataract surgery (SICS) or Phacoemulsification (PE). Phacoemulsification is preferred choice in the western developed countries or in urban settings. SICS is significantly faster, less expensive, and less technology dependent than phacoemulsification<sup>3</sup>. The visual acuity and the complication rates are similar to phacoemulsification (Ruit et al 2007)<sup>4</sup>. SICS may be the appropriate surgical procedure treatment of advanced cataract in the developing world. But often concern has been raised regarding the changes in the corneal thickness and endothelial cell loss following SICS<sup>5</sup>.

Corneal endothelium is metabolically active and responsible for keeping the corneal stroma in its usual dehydrated state of 70% water<sup>6</sup>. The normal endothelial cell density is approximately 2600 to 2800 cells/mm<sup>2</sup>.<sup>7</sup>

Endothelial injury may occur during cataract surgery due to number of factors such as corneal distortion, movement of nuclear fragments, release of free radicals, turbulence of irrigating solution and instrument contact<sup>8</sup>. Moderate damage of the corneal endothelium during surgery may lead to a transient increase in corneal thickness, all these things leads to swelling of cornea<sup>9</sup>. Since the cornea swells in the direction of thickness, therefore precise measurement corneal thickness serves as a parameter for assessing overall endothelial function<sup>10</sup>.

Some degree of endothelial cell loss invariably occurs in all types of cataract surgery but the

amount of endothelial cell loss varies with the surgical technique and the associated complications<sup>2</sup>. Therefore in this present study we made an attempt to access the relation between Central Corneal Endothelial Cell Density and Central Corneal Thickness after Small Incision Cataract Surgery and the effects of intraoperative complications.

## Materials and Methods

This study was conducted in Department Of Ophthalmology in Karwar Institute of Medical Sciences and Hospital between 2018 November-2019 October. The study was approved by the Institutional Review Board (Scientific) and written informed consent was obtained from all subjects prior to participation. Some of the consents were in local language to ensure validity. Patients were free to withdraw from the study at anytime and were assured that the study would not compromise the quality of their eye care.

This prospective study comprised of 222 patients who underwent small incision cataract surgery. Patients were selected by simple random sampling and were followed up for a 3 months.

### Source of data

- 1) Patients attending out patients department.
- 2) Patients referred from other department.

All patients underwent complete ophthalmic examination and biometry followed by measurement of central corneal thickness, specular microscopy (endothelial images) was performed at baseline (preoperative) and postoperatively at 1week, 2 weeks, 1 month and 3 months.

**Study Design:** Prospective Clinical Study.

**Sample Population:** Total 222patients which were divided into 3 groups

- G1 -Irrigating vectis technique-73 patients
- G2-Sandwich technique-75 patients
- G3 -Visco expression technique-74 patients.

### Inclusion Criteria

1. Patients with senile cataract with age group of 50 years and above were included in the study.

### Exclusion Criteria

- Coexisting ocular disease;
- 1) Increased intraocular pressure

- 2) Uveitis
- 3) Pseudo exfoliation; and poor pupillary dilatation.
- 4) Corneal dystrophy, corneal scarring
- An endothelial cell count (ECC) less than 1500 cells/mm<sup>2</sup>
- History of any intraocular surgery or ocular trauma.

**Observations**

The present prospective study was conducted in Department Of Ophthalmology in Karwar Institute of Medical Sciences and Hospital between 2018 November-2019 October. This study comprised of 222 patients who underwent small incision cataract surgery, which were divided into 3 groups and were followed up for a 3 months.

G1 -Irrigating vectis technique-73 patients

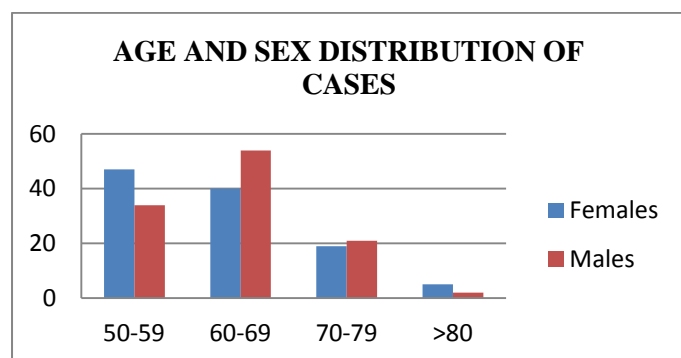
G2-Sandwich technique-75 patients

G3 -Visco expression technique-74 patients.

In this, we studied 42 complicated and 180 uneventful surgeries.

**Table 1:** Age and Sex wise distribution of patients

Age (years)	Females	% Females	Males	% Males	Total	% Total
50-59	47	42.3	34	30.6	81	36.5
60-69	40	36.0	54	48.6	94	42.3
70-79	19	17.1	21	18.9	40	18.0
>80	5	4.5	2	1.8	7	3.2
<b>Total</b>	<b>111</b>	<b>100.0</b>	<b>111</b>	<b>100.0</b>	<b>222</b>	<b>100.0</b>



**Table-3:** Pre-operative and Post-operative Endothelial cell density (cells/mm<sup>2</sup>) in Uneventful SICS patients.

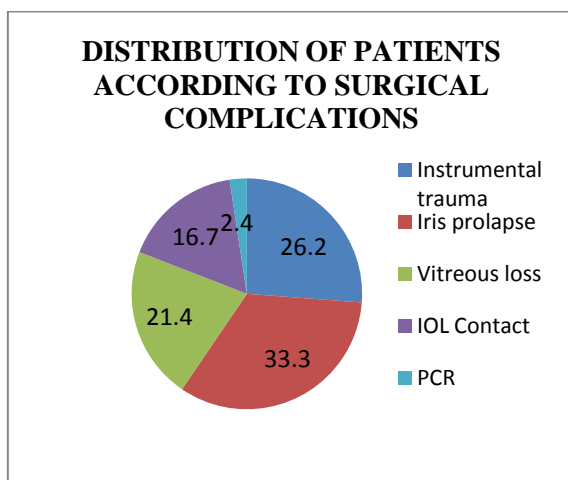
Complication	No of pts	Pre-op ECD (mean±SD)	1 <sup>st</sup> wk ECD (mean±SD)	2 <sup>nd</sup> wk ECD (mean±SD)	4 <sup>th</sup> wk ECD (mean±SD)	ECD at 3 months (mean±SD)	% Of Cell loss at 3 months post op	P value (Z test)
Uneventful	180	2745±279	2362±351	2296±392	2330±404	2485±369	9.5	<0.001

The above table and graph shows the age and sex wise distribution of 222 patients. The study was conducted on 222 patients.

The gender distribution of the study was uniform with 111 males and 111 females.

**Table-2:** Distribution of patients according to surgical complications

Complications	Frequency	Percent
Instrumental Trauma	11	26.2
Iris Prolapse	14	33.3
Vitreous Loss	9	21.4
IOL Contact	7	16.7
PCR	1	2.4
Total	42	100.0



Instrumental trauma occurred in 11 (26.2%) patients out of total patients with surgical complications. Iris prolapse occurred in 14 (33.3%) patients out of total patients with surgical complications. Vitreous loss occurred in 9 (21.4%) patients out of total patients with surgical complications. IOL contact occurred in 7 (16.7%) patients out of total patients with surgical complications. PCR occurred in 1(2.4%) patient out of total patients with surgical complications.

The above table and graph shows pre-operative and post-operative endothelial cell density in uneventful SICS patients.

In the 180 patients who had uneventful SICS and the mean ECD at 3 months was 2485±369

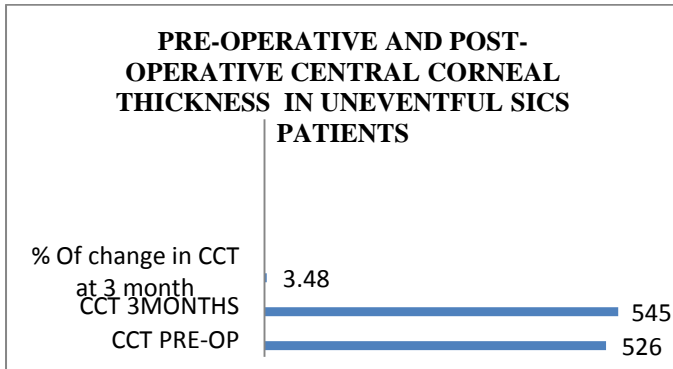
indicating 9.5 % of cell loss at 3 months post-operatively. (P value <0.001)

**Table-4:** Pre-operative and Post-operative central corneal thickness (microns) in Uneventful SICS patients

Complications	No of pts	Pre-op CCT (mean±SD)	1 <sup>st</sup> wk CCT (mean±SD)	2 <sup>nd</sup> wk CCT (mean±SD)	4 <sup>th</sup> wk CCT (mean±SD)	3month CCT (mean±SD)	% Of change in CCT at 3 month	P value
Uneventful	180	526±37	564±42	554±37	546±38	545±38	3.48	0.13

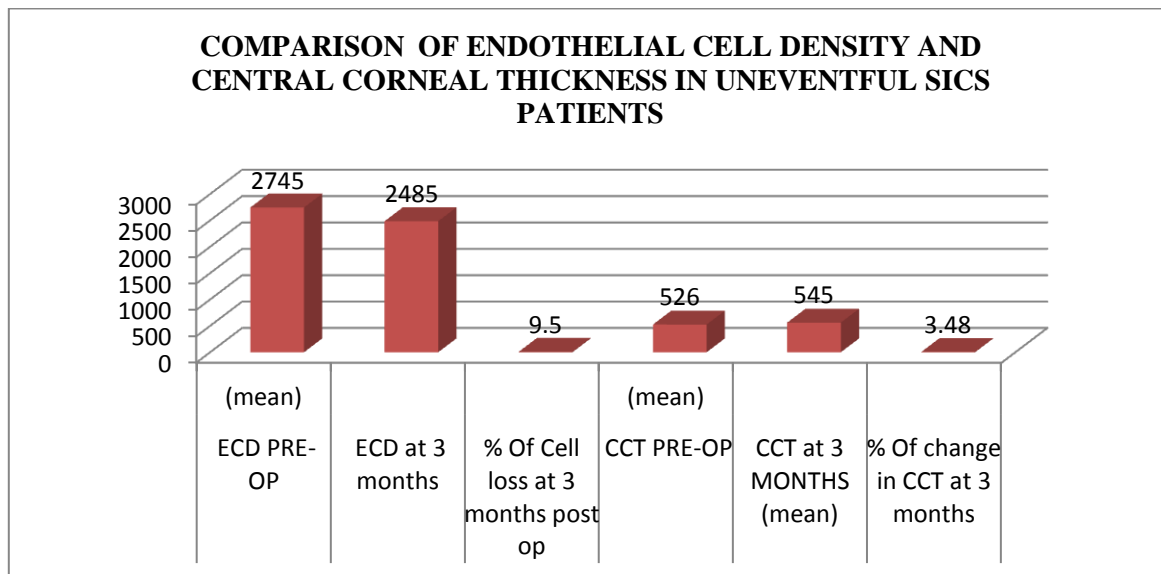
The above table and graph shows pre-operative and post-operative central corneal thickness in uneventful SICS patients.

In the 180 patients who had uneventful SICS, the mean CCT pre-operatively was 526±37 and the mean ECD at 3 months was 545±38 indicating 3.48 % change in CCT at 3 months post-operatively.



**Table-5:** Comparison of Endothelial cell density (cells/mm<sup>2</sup>) and central corneal thickness (microns) in uneventful SICS patients at 3 months post operative period.

Complication	No of pts	ECD pre-op (mean±SD)	CCT pre-op (mean±SD)	ECD at 3 months (mean±SD)	CCT at 3 months (mean±SD)	% Of Cell loss at 3 months post op	P value	% Of change in CCT at 3 months	P value
Uneventful	180	2745±279	526±37	2485±369	545±38	9.5	<0.001	3.48	0.13



The above table and graph shows comparison of endothelial cell density and central corneal

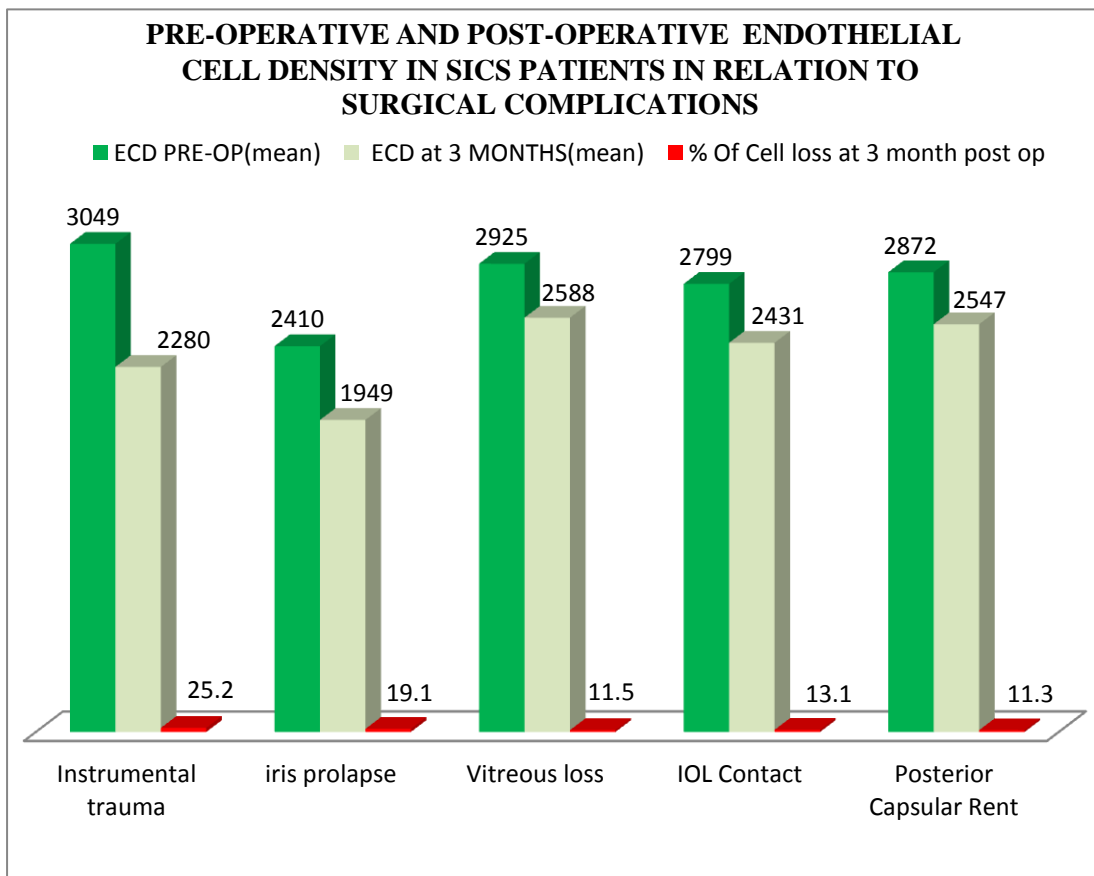
thickness pre-operatively and post-operatively at 3<sup>rd</sup> month in uneventful SICS patients.

In the 180 patients who had uneventful SICS, the mean ECD pre-operatively was 2745±279 and the mean ECD at 3 months was 2485±369 indicating 9.5 % of cell loss at 3 months post-operatively and

the mean CCT pre-operatively was 526±37 and the mean ECD at 3 months was 545±38 indicating 3.48 % change in CCT at 3 months post-operatively.

**Table-6:** Pre-operative and Post-operative Endothelial cell density (cells/mm<sup>2</sup>) in SICS patients in relation to surgical complications.

Complications	No of pts	Pre-op ECD (mean±SD)	1 <sup>st</sup> wk ECD (mean±SD)	2 <sup>nd</sup> wk ECD (mean±SD)	4 <sup>th</sup> wk ECD (mean±SD)	3months ECD (mean±SD)	% Of Cell loss at 3 month postop	P value
Instrumental trauma	11	3049±413	2480±362	2182±432	2127±572	2280±595	25.2	<b>0.001</b>
iris prolapse	14	2410±135	1873±144	1562±108	1437±630	1949±108	19.1	<b>0.001</b>
Vitreous loss	9	2925±387	2528±546	2370±460	2348±562	2588±380	11.5	<b>0.039</b>
IOL Contact	7	2799±195	2329±331	2348±442	2315±388	2431±325	13.1	<b>0.003</b>
Posterior Capsular Rent	1	2872±500	2549±576	2387±437	2465±469	2547±478	11.3	0.210
Total	42	2772±302	2377±371	2298±401	2322±423	2478±382	10.6	<b>&lt;0.001</b>



The above table and graph shows pre-operative and post-operative endothelial cell density in SICS patients in relation to surgical complications. In 11 patients with instrumental trauma, the mean ECD pre-op was 3049±413 and the mean ECD at 3 months was 2280±595 indicating 25.2% of cell loss at 3 months post-operatively.(p value0.001)

In 14 patients with iris prolapse, the mean ECD pre-op was 2410±135 and the mean ECD at 3 months was 1949±108 indicating 19.1% of cell loss at 3 months post-operatively. (p value0.001)

In 9 patients with vitreous loss, the mean ECD pre-op was 2925±387 and the mean ECD at 3 months was 2588±380 indicating 11.5% of cell loss at 3 months post-operatively. (p value0.039)

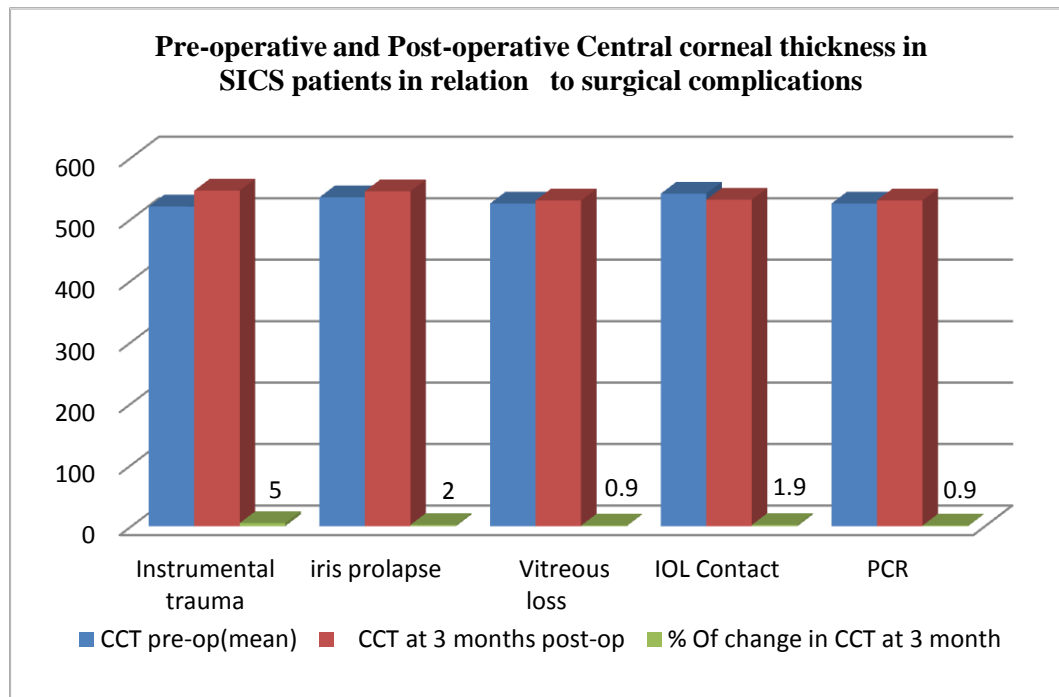
In 7 patients with IOL contact, the mean ECD pre-op was 2799±195 and the mean ECD at 3 months was 2431±325 indicating 13.1% of cell loss at 3 months post-operatively. (p value0.003)

In 1 patient with posterior capsular rent, the mean ECD pre-op was 2872±500 and the mean ECD at 3 months was 2547±478 indicating 11.3% of cell loss at 3 months post-operatively. (p value0.210)

In total 42 patients with complications, the mean ECD pre-op was 2772±302 and the mean ECD at 3 months was 2478±382 indicating 10.6% of cell loss at 3 months post-operatively.

**Table-7:** Pre-operative and Post-operative Central corneal thickness (microns) in SICS patients in relation to surgical complications.

Complication	No of pts	Preop CCT (mean±SD)	1 <sup>st</sup> wk CCT (mean±SD)	2 <sup>nd</sup> wk CCT (mean±SD)	4 <sup>th</sup> wk CCT (mean±SD)	CCT at 3months post-op (mean±SD)	% Of change in CCT at 3 month	P value (Z test)
Instrumental trauma	11	520±42	559±32	563±22	550±22	546±29	5.0	0.056
iris prolapse	14	535±56	590±31	562±45	551±28	545±27	2.0	0.059
Vitreous loss	9	525±49	550±46	531±50	513±51	530±49	0.9	0.082
IOL Contact	7	541±44	574±54	538±49	545±40	531±36	1.9	0.640
PCR	1	525±35	553±63	527±18	515±28	530±27	0.9	0.082
Total	42	527±39	565±42	554±38	545±37	557±28	5.8	0.124



The above table and graph shows pre-operative and post-operative central corneal thickness in SICS patients in relation to surgical complications. In 11 patients with instrumental trauma, the mean CCT pre-operatively was 520±42 and the mean CCT at 3 months post-operatively was 546±29 indicating 5% change in CCT at 3 months post-operatively.(p value 0.056)

In 14 patients with iris prolapse, the mean CCT pre-operatively was 535±56 and the mean CCT at 3 months post-operatively was 545±27 indicating 2% change in CCT at 3 months post-operatively. (p value 0.059)

In 9 patients with vitreous loss, the mean CCT pre-operatively was 525±49 and the mean CCT at 3 months post-operatively was 530±49 indicating 0.9%

change in CCT at 3 months post-operatively. (p value 0.082)

In 7 patients with IOL contact, the mean CCT pre-operatively was 541±44 and the mean CCT at 3 months post-operatively was 531±36 indicating 1.9% change in CCT at 3 months post-operatively. (p value 0.640)

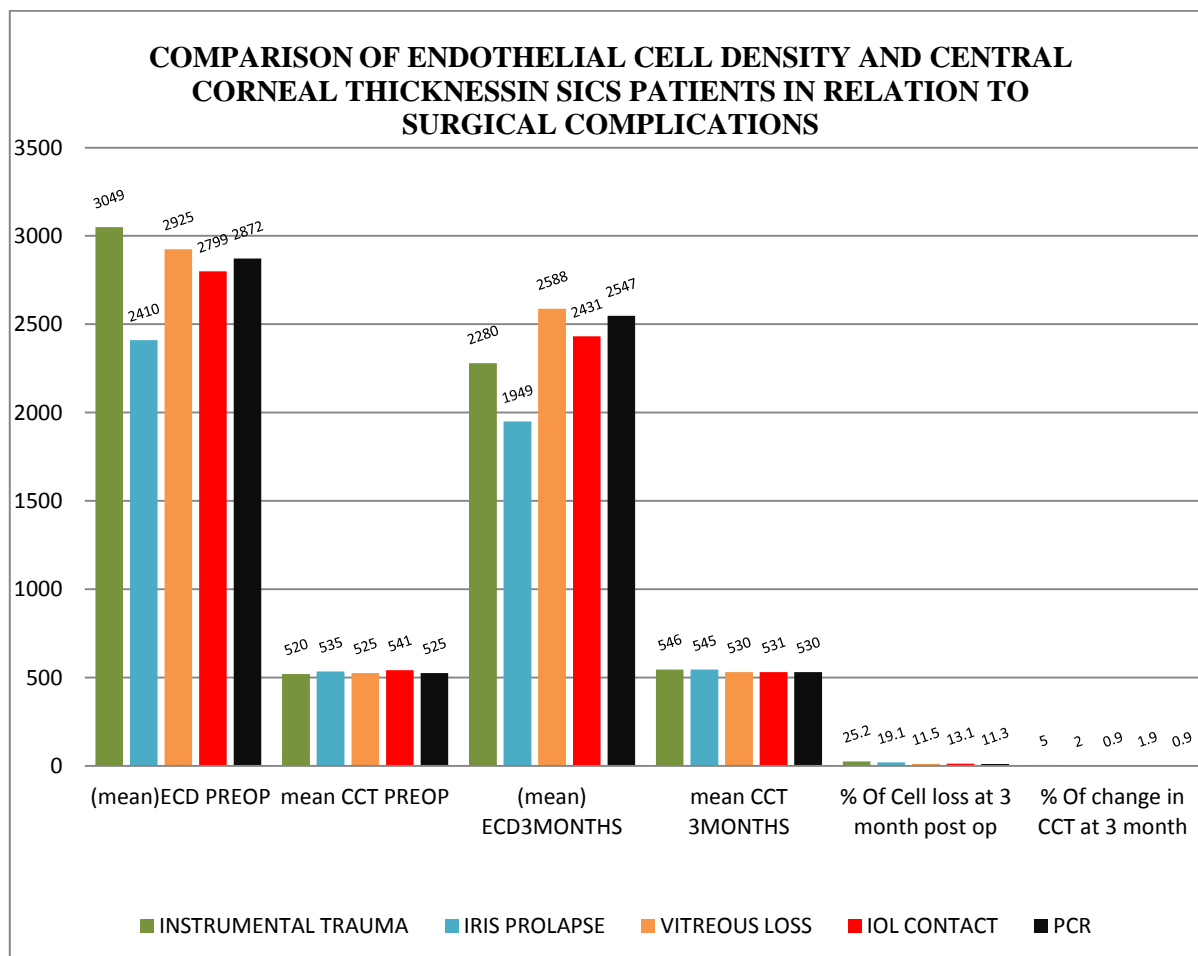
In 1 patient with posterior capsular rent, the mean CCT pre-operatively was 525±35 and the mean

CCT at 3 months post-operatively was 530±27 indicating 0.9% change in CCT at 3 months post-operatively. (p value 0.082)

In total 42 patients with all surgical complications, the mean CCT pre-operatively was 527±39 and the mean CCT at 3 months post-operatively was 557±28 indicating 5.8% change in CCT at 3 months post-operatively. (p value 0.124).

**Table-8:** Comparison of Endothelial cell Density (cells/mm<sup>2</sup>) and central corneal thickness (microns) in SICS patients in relation to surgical complications at 3 months post operative period.

Complication	No Of pts	Pre-op ECD (mean±SD)	Pre-op CCT (mean±SD)	3months ECD (mean±ECD)	3months CCT (mean±SD)	% Of Cell Loss At 3 Month Post Op	ECD P value	% Of Change In CCT At 3 Month	CCT p value
Instrumental Trauma	11	3049±413	520±42	2280±595	546±29	25.2	0.001	5.0	0.056
Iris Prolapse	14	2410±135	535±56	1949±108	545±27	19.1	0.001	2.0	0.059
Vitreous Loss	9	2925±387	525±49	2588±380	530±49	11.5	0.039	0.9	0.082
IOL Contact	7	2799±195	541±44	2431±325	531±36	13.1	0.003	1.9	0.640
PCR	1	2872±500	525±35	2547±478	530±27	11.3	0.210	0.9	0.082
Total	42	2772±302	527±39	2478±382	557±28	10.6	<0.001	5.8	0.124



The above table and graph shows comparison of endothelial cell density and central corneal thickness in SICS patients in relation to surgical complications.

In 11 patients with instrumental trauma, the mean ECD pre-op was  $3049 \pm 413$  and the mean ECD at 3 months was  $2280 \pm 595$  indicating 25.2% of cell loss at 3 months post-operatively. Also, the mean CCT pre-operatively was  $520 \pm 42$  and the mean CCT at 3 months post-operatively was  $546 \pm 29$  indicating 5% change in CCT at 3 months post-operatively.

In 14 patients with iris prolapse, the mean ECD pre-op was  $2410 \pm 135$  and the mean ECD at 3 months was  $1949 \pm 108$  indicating 19.1% of cell loss at 3 months post-operatively. Also, the mean CCT pre-operatively was  $535 \pm 56$  and the mean CCT at 3 months post-operatively was  $545 \pm 27$  indicating 2% change in CCT at 3 months post-operatively.

In 9 patients with vitreous loss, the mean ECD pre-op was  $2925 \pm 387$  and the mean ECD at 3 months was  $2588 \pm 380$  indicating 11.5% of cell loss at 3 months post-operatively. Also, the mean CCT pre-operatively was  $525 \pm 49$  and the mean CCT at 3 months post-operatively was  $530 \pm 49$  indicating 0.9% change in CCT at 3 months post-operatively.

In 7 patients with IOL contact, the mean ECD pre-op was  $2799 \pm 195$  and the mean ECD at 3 months was  $2431 \pm 325$  indicating 13.1% of cell loss at 3 months post-operatively. Also, the mean CCT pre-operatively was  $541 \pm 44$  and the mean CCT at 3 months post-operatively was  $531 \pm 36$  indicating 1.9% change in CCT at 3 months post-operatively.

In 1 patient with posterior capsular rent, the mean ECD pre-op was  $2872 \pm 500$  and the mean ECD at 3 months was  $2547 \pm 478$  indicating 11.3% of cell loss at 3 months post-operatively. Also, the mean CCT pre-operatively was  $525 \pm 35$  and the mean CCT at 3 months post-operatively was  $530 \pm 27$  indicating 0.9% change in CCT at 3 months post-operatively.

In the total 42 patients with complications, the mean ECD pre-op was  $2772 \pm 302$  and the mean ECD at 3 months was  $2478 \pm 382$  indicating 10.6% of cell loss at 3 months post-operatively. Also, the mean CCT pre-operatively was  $527 \pm 39$  and the mean CCT at 3

months post-operatively was  $557 \pm 28$  indicating 5.8% change in CCT at 3 months post-operatively.

### Conclusion

The present study comprised of 222 cases who underwent small incision cataract surgery between 2018 November-2019 October in Department Of Ophthalmology in Karwar Institute of Medical Sciences and Hospital Karwar. The results of surgery were studied prospectively over a 3 month period with follow ups at 1 week, 2 weeks, 1 month and 3 months. In this present study attempt was made to access the relation between Central Corneal Endothelial Cell Density and Central Corneal Thickness after small incision cataract surgery and effect of various factors like intra operative complications.

### Age & Gender Distribution

The study was conducted on 222 patients out of which 50% were males and rest females. Out of 222 patients, 81 (36.5%) patients were in the age group of 50-59 years of whom 47 (42.3%) patients were females and 34 (30.6%) were males. 94 (42.3%) patients were in the age group of 60-69 years of whom 40 (36.0%) patients were females and 54 (48.6%) were males. 40 (18.0%) patients were in the age group of 70-79 years of whom 19 (17.1%) patients were females and 21 (18.9%) were males. 7 (3.2%) patients were in the age group of >80 years of whom 5 (4.5%) patients were females and 2 (1.8%) were males.

### Effect of Surgical Complications on Endothelial Cell Density and Central Corneal Thickness in SICS Patients

In the present study, total 222 patients underwent SICS with PCIOL which were divided into 3 groups: G1 -Irrigating vectis technique-73 patients G2 -Sandwich technique-75 patients G3 -Visco expression technique-74 patients 73 patients were operated with irrigating vectis technique, in that total complications were 24 (57.14%), including instrumental trauma 6 (14.28%), iris prolapse 8 (19.04%), vitreous loss 6 (14.28%), IOL contact 3 (7.14%) and PCR 1 (2.38%). The %



of endothelial cell loss and increase in CCT with this technique was 16.07% and 11.9%.

**Wright et al (1994)**<sup>12</sup> performed SICS in 90 eyes using irrigating vectis technique. They reported 14.4% endothelial cell loss and 10.8% increase in central thickness at 1 month and 10.1% endothelial cell loss and 7.2% increase in central corneal thickness at 4 month. Complications were posterior capsule rupture 8.1%, instrumental trauma 7.2%, vitreous loss 1.8% and others 3.6%.

**Thakur et al (2011)**<sup>13</sup> performed SICS in 150 eyes using irrigating technique. At the end of 3 months complications reported were surgical trauma 12.6%, iris prolapsed 10.8%, posterior capsular rupture 5.4% and vitreous loss 3.6% and there was 16 % endothelial cell loss.

In our study, 75 patients were operated with sandwich technique, in that total complications were 9 (21.42%), which includes instrumental trauma 3 (7.14%), iris prolapse 2 (4.76%), vitreous loss 2 (4.76%), IOL contact 2 (4.76%) and no PCR. The % of endothelial cell loss and increase in CCT with this technique was 10.46% and 2.1%.

**Smith et al (1992)**<sup>14</sup> performed SICS in 60 eyes using sandwich technique. After 3 months there was 10.2% endothelial cell loss and 6% increase in central corneal thickness. Complications were instrumental trauma 6.3%, iris prolapsed 4.5%, posterior capsule rupture (2%) and vitreous loss 1.8%.

**Jacobs PM et al (1994)**<sup>15</sup> performed SICS in 90 eyes using sandwich technique. They reported 12.6% endothelial cell loss and 8.1% increase in central thickness at 1 month and 8.1% endothelial cell loss and 5.4% increase in central corneal thickness at 4 month. Complications were posterior capsule rupture 3%, instrumental trauma 7%, vitreous loss 1.8% and others 2%.

In our study, 74 patients were operated with visco expression technique, in that total complications were 9 (21.42%), which includes instrumental trauma 2 (4.76%), iris prolapse 4 (9.52%), vitreous loss 1 (2.38%), IOL contact 2 (4.76%) and no single PCR observed. With visco expression technique

there was 5.26% endothelial cell loss and 1.8% increase in CCT.

**Rao GN and Stevens et al (1994)**<sup>16</sup> performed SICS in 90 eyes using visco expression technique. They reported 12.6% endothelial cell loss and 8.1% increase in central thickness at 1 month and 8.1% endothelial cell loss and 5.4% increase in central corneal thickness at 4 month. Complications were posterior capsule rupture 3%, instrumental trauma 7%, vitreous loss 1.8% and others 2%.

**Sunil Ganekal et al (2014)**<sup>17</sup> performed SICS in 100 eyes using visco expression technique. They reported 13.9% endothelial cell loss. Complications were posterior capsule rupture 3%, instrumental trauma 7%, vitreous loss 1.8% and others 2%.

#### Uneventful Surgery

In this present study, out of 222 patients, 180 patients had uneventful Small Incision Cataract Surgery, the mean ECD pre-operatively was  $2745 \pm 279$  and the mean ECD at 3 months was  $2485 \pm 369$  indicating 9.5 % of cell loss at 3 months post-operatively (p value < 0.001) and the mean CCT pre-operatively was  $526 \pm 37$  and the mean ECD at 3 months was  $545 \pm 38$  indicating 3.48 % change in CCT at 3 months post-operatively (p value 0.13).

Our study correlate with studies of uneventful cataract extraction reported by **Kraff et al (1980)**<sup>18</sup> showed a mean endothelial cell loss of 12.3%.

**Bourne et al (1988)**<sup>19</sup> reported an average of 10% reduction in endothelial cell count by one year after uneventful phacoemulsification and ECCE.

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