ORIGINAL ARTICLE

Comparative Study of Corneal Endothelial Changes after Both Phacoemulsification and Manual Small-incision Cataract Surgery

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Abstract

Background: ***Cataract is recognized as a primary etiology of reversible vision impairment globally.***

Aim: ***This investigation aimed to compare the impact of phacoemulsification operation and manual small-incision cataract operation on the endothelium of cornea, utilizing a specular microscope preoperatively, at one month, and at three months postoperatively, to ascertain which procedure preserves corneal parameters most closely to the normal physiological condition.***

Patients and methods: ***This was randomized interventional comparative research included forty eyes. The patients recruited from ophthalmology department Sayed Galal hospital Al-Azhar University and Qalwoon ophthalmic hospital.***

Results: ***The comparison among both groups revealed a statistically significant difference in the mean central corneal thickness 1 month postoperatively (P-value equal 0.016) being significantly higher in group A compared to group B, while statistically insignificant variance was detected among both groups preoperatively, one month and three months after operation.***

Conclusion: ***Manual Small Incision Cataract Surgery (MSICS) is safer for the endothelium of cornea than phacoemulsification operation. MSICS and Phacoemulsification both resulted in excellent visual outcomes with few complications, showing no substantial difference between the two procedures. MSICS is less costly, less reliant on technology, capable of addressing all cataract varieties, generally safe, and better suited for advanced cataracts in developing countries.***

Keywords: Corneal Endothelium; Small Incision Cataract Surgery; Phacoemulsification

1. Introduction

Cataract is recognized as a primary etiology of reversible visual impairment globally. [1] The prevalence of cataracts is increasing due to older people, rendering it an international health problem.[2]

The cornea is a transparent structure comprising the anterior one-sixth of the eyeball and consists of six different layers.[3]

Small incision cataract surgery (SICS) and Phacoemulsification have gained prominence as prevalent cataract procedures. Phacoemulsification is the predominant technique for cataract procedures in developed nations. Nonetheless, Phacoemulsification involves significant expenses and maintenance requirements for the apparatus. Consequently, significant efforts have been made in underdeveloped nations to render surgery for cataracts more economically.[4]

Ultrasonic pachymetry is the prevalent technique for measuring corneal thickness; nevertheless, numerous novel tools, including specular microscopy, have been created to concurrently assess corneal thickness and analyze the corneal endothelium.[5]

The assessment of endothelial health is based on metrics like the percentage of hexagonal endothelial cells, the density of endothelial cells, and the coefficient of variation in cell area. An increase in the variation of cell area is termed polymegathism. A deviation from a hexagonal structure is referred to as pleomorphism. The ratio of hexagonal cells (pleomorphism) and the coefficient of variation in cell area (polymegathism) increase with age and the loss of endothelial cells due to various reasons.[6]

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The loss of endothelial cells throughout the operation may be associated with the extent of trauma incurred throughout cataract procedures.[7] It is also affected by many preoperative and during surgery factors. [8]

This investigation aimed to compare the impact of phacoemulsification operation & manual small-incision cataract procedure on the endothelium of cornea, utilizing a specular microscope for assessments preoperatively, at one month, and at three months postoperatively, to identify which technique preserves corneal parameters most closely aligned with the normal physiological state.

2. Patients and methods

This randomized interventional comparative research included forty eyes. The patients recruited from ophthalmology department Sayed Galal hospital Al-Azhar University and Qalwoon ophthalmic hospital. Subjects separated into 2 groups: Group (A): Twenty cataract eyes had phacoemulsification surgery and Group (B): Twenty cataract eyes were treated by small-incision cataract surgery.

Inclusion criteria: Age ranged between 40 - 70 years, Patients having visually significant cataract and both genders were included.

Exclusion criteria: Cases with complex or traumatic cataracts, corneal conditions including scarring, endothelial dystrophy, opacity, cataracts related to glaucoma, a history of previous ocular operations, and any systemic disorders impacting the eye.

Methods

All cases have been exposed to the following:

History: General medical history: history of any associated systemic condition, ocular history: history of ocular inflammation, ocular trauma and ocular surgeries and medication (Topical, periocular, and systemic medications). Examination: Ocular examination done as assessment of Best corrected visual acuity (BCVA) and Uncorrected visual acuity (UVA), measurement of IOP using Goldman applanation tonometer, Slit-lamp biomicroscopic examination & dilated fundus examination. Investigations: A non-contact specular microscopy has been utilized to assess the endothelial cell count and central corneal thickness for all preoperative cases, 1 month and 3 months postoperative.

Surgical technique

Phacoemulsification cataract surgery

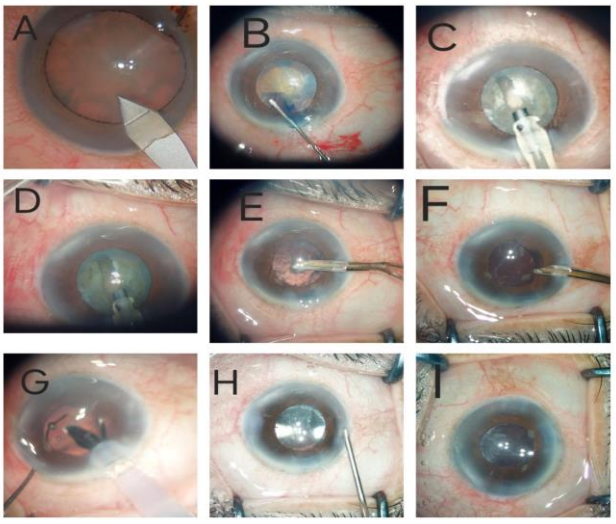

Figure 1. A, corneal incision with keratome 2.8mm. B, continuous curvilinear capsulorrhexis with 26 G needle cystitome. C&D, Phacoemulsification with cracking in the posterior chamber. E&F irrigation and aspiration of cortical matter. G, IOL implantation. H, hydration of main and side port incisions.

Manual Small incision cataract surgery:

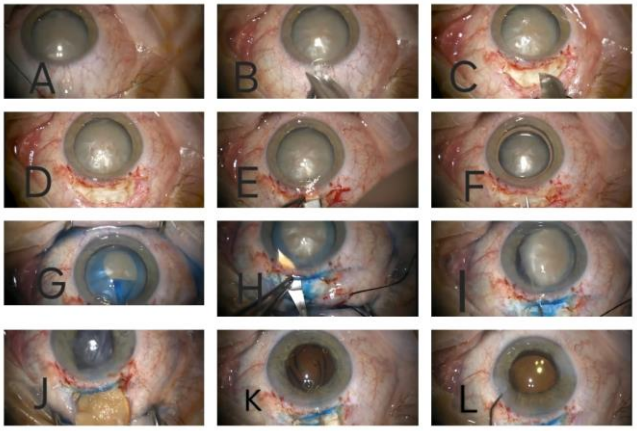

Figure 2. A, bridle suture. B, conjunctival periotomy. C&D sclerocorneal tunnel construction with straight incision. E, dissecting the tunnel with a crescent knife. F,tryban blue injection. G, continuous curvilinear capsulorrhexis with 26 G needle cystitome. H, anterior chamber entry using keratome 3.2 mm. I, nucleus prolapse in the anterior chamber using Sinskey hook. J, nucleus delivery vectis. K, IOL implantation. L, hydration of the side incision.

Informed consent: All cases have been apprised of the procedural information, and signed informed consent has been requested.

Medical ethical committee: The medical ethical committee reviewed the ethical and legal aspects of this protocol.

Statistical analysis

Statistical analysis was conducted using SPSS version 28 (IBM Co., Armonk, New York, United States of America). Quantitative data have been expressed as the mean and standard deviation (SD), examined over time points within each group utilizing Repeated Measures ANOVA, and compared among groups utilizing an unpaired t-test. Categorical data have been expressed as percentages and frequencies, evaluated over time points within each group utilizing the Wilcoxon signed-rank test, and compared among groups utilizing the Chi-square test. A two-tailed P value of less than 0.05 has been deemed statistically significant.

3. Results

A statistically insignificant variance has been observed among both groups according to age and gender distribution P-value more than 0.05. (Table 1)

Table 1. baseline characteristics of the examined groups

		GROUP A (NUMBER=TWENTY)	GROUP B (NUMBER=TWENTY)	P-VALUE
AGE (YEARS)	Mean ± SD	55.5 ± 7.75	58.35 ± 6.6	0.218
	Range	43 - 70	46 - 69	
GENDER	Male	11 (55%)	8 (40%)	0.342
	Female	9 (45%)	12 (60%)	

Data are presented as frequency (%) unless otherwise mentioned.

The comparison among both groups revealed statistically insignificant variance as regards BCVA results pre and postoperatively p-value more than 0.05. (Table 2)

Table 2. Best corrected visual acuity on Snellen's chart results of the examined groups

		GROUP A (NUMBER=TWENTY)	GROUP B (NUMBER=TWENTY)	P VALUE
PREOPERATIVE	>6/18	7 (35%)	3 (15%)	0.204
	6/24 -6/60	11 (55%)	11 (55%)	
	<6/60	2 (10%)	6 (30%)	
POSTOPERATIVE	>6/18	16 (80%)	16 (80%)	>0.999
	6/24 -6/60	3 (15%)	3 (15%)	
	<6/60	1 (5%)	1 (5%)	
P VALUE (TIME-POINTS)		0.002*	<0.001*	

Data are presented as frequency (%), *: Statistically significant as P value<0.05, BCVA: Best corrected visual acuity

The comparison between both groups revealed a statistically significant difference in the mean CCT 1 month postoperatively (P-value equal 0.016) being significantly higher in group A compared to group B, while statistically insignificant variance has been identified among both groups preoperatively and after 3 months p-value more than 0.05. (Table 3)

Table 3. Mean central corneal thickness (micron) of the examined groups

		GROUP A (NUMBER=TWENTY)	GROUP B (NUMBER=TWENTY)	P VALUE
PREOPERATIVE	Mean ± SD	529.25 ± 16.5	526 ± 16.92	0.542
	Range	495 - 549	497 - 555	
POSTOPERATIVE 1 MONTH	Mean ± SD	550.1 ± 14.6	538.05 ± 15.54	0.016*
	Range	517 - 567	514 - 562	
3 MONTHS	Mean ± SD	531.4 ± 18.28	528.8 ± 17.79	0.651
	Range	498 - 552	490 - 555	
P VALUE (TIME-POINTS)		<0.001*	<0.001*	
PAIRWISE COMPARISON		P1<0.001*, P2=0.164, P3<0.001*	P1<0.001*, P2=0.039*, P3<0.001*	

P1: Comparison between preoperative & 1-month measurements, P2: Comparison between preoperative & 3 months' measurements, P3: Comparison between 1 & 3 months' measurements.

The comparison between both groups revealed a statistically significant variance regarding the mean endothelial cell count 3 months postoperatively (P=0.042) being significantly lower in group A compared to group B, while statistically insignificant variance has between both groups preoperatively and after 1-month p>0.05. (Table 4)

Table 4. Mean endothelial cell count (cells/mm2) of the examined groups

		GROUP A (NUMBER=TWENTY)	GROUP B (NUMBER=TWENTY)	P VALUE
PREOPERATIVE	Mean ± SD	2479.95 ± 267.97	2543.55 ± 272.81	0.462
	Range	1983 - 2915	2124 – 2975	
POSTOPERATIVE 1 MONTH	Mean ± SD	2358.75 ± 250.15	2384 ± 231.29	0.742
	Range	1910 - 2817	2095 – 2764	
3 MONTHS	Mean ± SD	2158.9 ± 229.28	2312.5 ± 233.3	0.042*
	Range	1746 - 2595	1994 – 2742	
P VALUE (TIME-POINTS)		<0.001*	<0.001*	
PAIRWISE COMPARISON		P1<0.001*, P2<0.001*, P3<0.001*	P1<0.001*, P2<0.001*, P3=0.015*	

4. Discussion

The corneal endothelium is a hexagonal, non-replicating neural crest-derived tissue layer that maintains corneal clarity by removing excess fluid from the stroma, thus keeping it dry. CCT) is crucial for evaluating the impact of refractive and intraocular surgeries on the cornea's structure and function, as well as for assessing the cornea following the administration of different drugs.[9]

In our research, group A (Phacoemulsification) comprised eleven men (fifty-five percent) and nine females (forty five percent), with a mean age of 55.5 ± 7.75 years (ranging from forty-three to seventy years), whereas group B (MSICS) consisted of eight men (forty percent) and twelve females (sixty percent), with a mean age of 58.35 ± 6.6 years (ranging from forty-six to sixty-nine years). No statistically significant distinction has been seen between the two groups in terms of age and gender distribution.

Kumar et al.[10] carried out prospective observational research over fifteen months involving one hundred eyes, of whom forty-three cases had phacoemulsification operation and fifty-seven had manual small incision cataract surgery. A total of one hundred cases participated in the study without any dropouts, comprising forty-three (forty-three percent) in the phacoemulsification group and 57 (fifty-seven percent) in the MSICS group. The research population's age varied from forty to seventy years. In the phacoemulsification group of forty-three patients, twenty-one (48.83%) were male and twenty-two (51.16%) were female. In the MSICS group of fifty-seven subjects, 25 (43.86%) were male and thirty-two (56.14%) were female.

In group A (Phacoemulsification), 35% of cataract eyes elicited BCVA >6/18 on Snellen's chart, 55% elicited BCVA between 6/24 – 6/60, and only 10% had BCVA <6/60 preoperatively, and those results were significantly changed postoperatively (P=0.002) as most patients (80%) had BCVA >6/18, 15% had BCVA between 6/24 – 6/60 and 5% had BCVA <6/60. In group B (MSICS), 15% of cataract eyes elicited BCVA >6/18 on Snellen's chart, 55% elicited BCVA between 6/24 – 6/60, and 30% had BCVA <6/60 preoperatively, and those results were significantly changed postoperatively (P<0.001) as most patients (80%) had BCVA >6/18, 15% had BCVA between 6/24 – 6/60 and 5% had BCVA <6/60. The comparison between the two groups revealed no statistically significant difference.

Gogate et al.[11] investigated four hundred eyes and observed unassisted vision of 6/18 or better at six weeks in 81.08 percent of those undergoing Phacoemulsification and in 71.1 percent of those undergoing MSICS. Following rectification, these figures were enhanced to 98.4 percent in both groups.

Cataract eyes in group A (subjected to phacoemulsification surgery) had a mean central corneal thickness of 529.25 ± 16.5 microns preoperatively, which was significantly increased 1 month postoperatively to 550.1 ± 14.6 microns (P<0.001). After 3 months, the mean CCT was 531.4 ± 18.28 micron, which was insignificantly different than preoperative measurement but significantly lower than that after 1 month (P<0.001).

Cataract eyes in group B (subjected to MSICS) had a mean central corneal thickness of 526 ± 16.92 microns preoperatively, which was significantly increased 1 month postoperatively to 538.05 ± 15.54 microns (P<0.001). After 3 months, the mean CCT was 528.8 ± 17.79 µm, which

was significantly higher than preoperative measurement (P=0.039) but significantly lower than that after 1 month (P-value less than 0.001).

The comparison between the two groups demonstrated a statistically significant distinction in the mean central corneal thickness one month following surgery (P-value equal 0.016), with group A exhibiting a significantly greater mean than group B. However, a statistically insignificant distinction has been observed among the groups before surgery or for three months following surgery.

One week following surgery, Ganekal et al. [12] reported a mean rise in corneal thickness of 9.44 micrometers in the first group & 10.48 micrometers in the second group. At six weeks following surgery, the average corneal thickness reduced by 3.44 micrometers in the first group & increased by one micrometer in the second group. The mean variance in CCT at baseline and one week among the first group and the second group was statistically significant (P-value equals 0.027). Nevertheless, the baseline variation between six weeks and one week, as well as across six weeks, was statistically insignificant (P-value more than 0.05, all comparisons). This search corroborates our findings of a statistically significant distinction between the two groups following one month, although it diverges in indicating that the difference was greater in group A compared to group B. Additionally, it aligns with our research in demonstrating statistically insignificant distinction among the groups preoperatively, following three months, as well as following six weeks in their research.

In the research performed by Kumar et al.[10] the prior surgery mean central corneal thickness was 530.29 ± 11.34 micrometers in the phacoemulsification group and 526.82 ± 8.91 micrometers in the small incision cataract surgery group (P-value equal 0.087). The mean central corneal thickness following surgery was 593.06 ± 16.64, 548.32 ± 13.48, and 533.35 ± 18.69 micrometers in the phacoemulsification group, & 561.30 ± 9.13, 536.28 ± 6.43, & 527.94 ± 7.81 micrometers in the small incision cataract surgery group at day one (P-value less than 0.001) and the third week (P-value less than 0.001).

Our findings contrast with those of Mencucci et al.,[13] who investigated corneal endothelial cell alterations following Phacoemulsification compared to a bimanual microincision cataract surgical method. He determined that there was no variation in corneal endothelial cell loss, corneal thickness, & endothelial morphology among the groups after one month and three months.

Deshpande et al.[14] conducted a prospective randomized trial with 101 cases aged fifty to

seventy years old presenting with cataracts; fifty-one cases had manual small incision cataract surgery, and fifty cases got Phacoemulsification. The average central corneal thickness was 518.46 micrometers before surgery, 533.78 micrometers on seventh day, and 524.9 micrometers on day thirty.

A statistically significant elevation in central corneal thickness was seen on days seven and thirty. That is agree also with our results on CCT after 1 month.

In group A (subjected to phacoemulsification surgery), the mean count of endothelial cells was 2479.95 ± 267.97 cells/mm2 preoperatively, which was significantly decreased 1 and 3 months postoperatively to 2358.75 ± 250.15 and 2158.9 ± 229.28 cells/mm2, respectively (P<0.001). The measurement post 3 months was significantly lower than that post 1 month (P<0.001).

In group B (subjected to MSICS), the mean endothelial cell count was 2543.55 ± 272.81 cells/mm2 preoperatively, which was significantly decreased 1 and 3 months postoperatively to 2384 ± 231.29 and 2312.5 ± 233.3 cells/mm2, respectively (P<0.001). The measurement post 3 months was significantly lower than that post 1 month (P=0.015).

The comparison between both groups revealed a statistically significant variance regarding the mean endothelial cell count 3 months postoperatively (P=0.042) being significantly lower in group A than group B, while statistically insignificant variance was detected among both groups preoperatively and following 1 month.

The findings from our first month diverge from those of the research done by Ganekal et al. [12]; during six weeks, there was a reduction in cell density of 76.12 cells/mm² (3.27 percent) for Phacoemulsification and 315.08 cells/mm² (13.49%) for manual small incision cataract surgery. The variation in mean density of endothelial cells at one week & six weeks was statistically significant (P-value equal to 0.016). This indicates that in Group one, the mean endothelial cell density at one and six weeks stabilized and was sustained, but the cell density in the manual small incision cataract surgery at one and six weeks was significantly diminished.

The differential loss of endothelial cells was significant among both groups (P-value less than 0.01) on day one and the third week, but insignificant at six weeks postoperatively (P-value over 0.05). These results align with our findings on endothelial count, indicating no significant distinction between the two groups after one month.

A separate Indian investigation carried out by Kaur et al.[15] found that the average endothelial cell loss in small incision cataract surgery was 165.81 (6.60 percent), 274.03 (10.95 percent), 359.16 (14.41 percent), & 427.51 (17.17%) cells/mm² on days one, seven, twenty-eight, & forty-two, correspondingly. In Phacoemulsification, the average endothelial cell loss was 205.24 (8.22 percent), 326.81 (12.96 percent), 418.36 (16.64 percent), and 494.04 (19.53 percent) cells/mm² on days one, seven, twenty-eight, and forty-two, correspondingly, with statistically insignificant distinction seen. All these findings corroborate our research.

4. Conclusion

MSICS is safer for the corneal endothelium than phacoemulsification operation. Phacoemulsification & MSICS both resulted in excellent visual outcomes with little complications, showing no substantial difference between the two procedures. MSICS is less cost, less reliant on technology, capable of addressing all cataract varieties, generally safe, and better suited for advanced cataracts in developing countries.

Disclosure

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Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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