

Morphological Changes in the Endothelium of Cornea after Cataract Surgery: A Comparison between Phacoemulsification and Manual Small Incision Cataract Surgery

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ABSTRACT

Background: Endothelial cell loss and corneal decompensation after cataract surgery is well-documented. After endothelial cell loss, the adjacent cells enlarge and slide over to maintain endothelial cell continuity, which is observed as a change in the endothelial cell density and morphology of the cornea.

Objective: The study aims to assess and compare morphological changes (i.e., endothelial cell loss) in cornea after phacoemulsification with posterior chamber intraocular lens (PCIOL) implantation and manual small incision cataract surgery (MSICS) with PCIOL implantation.

Methods: This observational study was conducted in the Department of Ophthalmology of Combined Military Hospital (CMH), Dhaka Cantonment, Dhaka, Bangladesh, between January and July of 2016. A total of 80 patients of age-related cataract were randomly selected based on inclusion and exclusion criteria. All patients underwent complete ophthalmic evaluation pre- and post-operatively (at day 1, after 1 week and 3 months) specifically for observation of the endothelial changes in cornea. Specular microscopy was done to assess corneal endothelial change.

Results: The mean endothelial cell count was found decreased at day 1 ($2585.07 \pm 355.65/\text{mm}^2$ vs. $2598.07 \pm 385.76/\text{mm}^2$), after 1 week ($2564.72 \pm 347.23/\text{mm}^2$ vs. $2388.77 \pm 326.46/\text{mm}^2$) and after 3 months ($2476.72 \pm 346.69/\text{mm}^2$ vs. $2248.77 \pm 354.47/\text{mm}^2$) following phacoemulsification and MSICS from their preoperative values ($2745.35 \pm 395.27/\text{mm}^2$ vs. $2673.04 \pm 388.28/\text{mm}^2$) respectively. However, no significant difference was observed in mean endothelial cell count of both groups ($P > 0.05$). The mean percentage of endothelial cell loss were observed $5.84 \pm 10.02\%$ and $2.80 \pm 0.65\%$ at day 1, $6.58 \pm 12.15\%$ and $10.63 \pm 15.92\%$ at 1 week, $9.78 \pm 12.29\%$ and $15.87 \pm 8.71\%$ at 3 months after phacoemulsification and MSICS. However, the difference observed in amount of endothelial cell loss between the groups was not statistically significant ($P > 0.05$).

Conclusion: To summarize, a decreased endothelial cell count was observed after cataract surgery in both phacoemulsification and MSICS procedures from their preoperative values respectively. However, the difference was not significant between two procedures.

Keywords: Endothelial cell count, endothelial cell loss, phacoemulsification, small incision cataract surgery

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INTRODUCTION

The cornea is the anterior transparent part of the eye that refracts light and helps us to see.¹ Corneal endothelial layer is a simple squamous or low cuboidal monolayer, which is 5 μm thick on an average having about 5,00,000 cells.² These cells are responsible for regulating fluid and solute transport and maintenance of corneal optical transparency.^{2,3} Morphological stability of the corneal endothelium is necessary to maintain long-term corneal

transparency.⁴ Endothelial cell loss and corneal decompensation after cataract surgery is well-documented.^{4,5} After endothelial cell loss, the adjacent cells enlarge and slide over to maintain endothelial cell continuity, which is observed as a change in the endothelial cell density and morphology.⁴⁻⁷

Several studies have shown that changes occur in endothelial cell density due to cataract surgery which signifies a morphological change of cornea,⁴⁻⁷ whereas other studies did not find any statistical differences.^{8,9} Hence, controversies prevail, and no definite conclusions have been drawn to date. Phacoemulsification is considered the gold-standard procedure for cataract.¹⁰ However, manual small incision cataract surgery (MSICS) has appeared as a popular procedure of choice in the surgical treatment of cataracts as it is less expensive and is as effective as phacoemulsification.¹⁰ Both techniques are advantageous for being suture less procedure and required small incision.^{10,11} After surgical trauma, the endothelium shows practically no proliferative activity, and the damaged area is covered by means of cell migration.^{12,13}

Nonetheless, no such study reports are available in our country. Therefore, the present study aims to assess and compare morphological changes (amount of endothelial cell loss) in cornea after phacoemulsification with posterior chamber intraocular lens (PCIOL) implantation and manual small incision cataract surgery (MSICS) with PCIOL implantation in a Bangladeshi population.

METHODS

This observational study was conducted in Department of Ophthalmology of Combined Military Hospital (CMH), Dhaka Cantonment, Dhaka, Bangladesh, between January and July of 2016. After taking written informed consent, a total of 80 cataract patients with age ranging from 40 to 70 years were selected. They were randomly allocated into two groups. One group consists of 40 cataract patients who underwent phacoemulsification with PCIOL implantation, while the other group consists of 40 cataract patients underwent manual small incision cataract surgery (MSICS) with PCIOL implantation. Patients with pre-operative astigmatism more than ± 1.00 D and post-operative more than ± 1.5 D with K1-K2 in keratometric reading, intra-operative use of sutures, corneal diseases like any pre-existing scar,

any interstitial keratitis, peripheral corneal degeneration, dry eye, limited visual potential after cataract surgery like amblyopia, maculopathy, glaucoma, diabetic retinopathy, previous retinal detachment surgery, optic atrophy were excluded from the study. Detail history and physical examination of each patient was performed and recorded. Anterior segment was examined by torch and slit lamp biomicroscope to evaluate lids, conjunctiva, cornea, anterior chamber, pupil, iris, lens and anterior vitreous (where possible). Visual acuity and extra-ocular muscle balance were tested. Posterior segment was examined by direct and indirect ophthalmoscope. Retinal and macular functions were tested by projection of rays in different quadrants, two-points discrimination, Maddox rod and colour perceptions test. Intra-ocular pressure was measured by applanation tonometer and sac patency test was done to exclude the possible source of infection. All patients were examined pre-operatively and post operatively after day 1, after 1 week and 3 months following surgery for evaluation of corneal endothelial change. Keratometric cylinder was measured by using an Autorefractometer (Nidek AR-1, Tokyo, Japan) and Autokeratometer (Grand Seiko; GR-3100K, Shigiya Machinery Works Ltd, Japan) to find out the K1 and K2 reading for flat and steep meridian. Astigmatism was calculated from keratometric data using vector analysis. Specular microscopy was done to analyze corneal endothelial cell count. Uncorrected and best corrected visual acuity for all patients were measured in all examination visits. Subjective refraction was done for all patients with Snellen chart, trial frame and trial lens. Most of the operation was done under local anesthesia and few with topical anesthesia. Standard operative procedure was followed in the phacoemulsification and PCIOL implantation and manual small incision cataract surgery and PCIOL implantation.

All the data were compiled, sorted properly, and analyzed statistically using Statistical Package for Social Science (SPSS) version 20.0. Chi-square tests, unpaired and paired Student's 't' test were performed to compare between the groups. P value < 0.05 was considered as significant. Ethical clearance was obtained from the Institutional Review Board (IRB) of Combined Military Hospital, Dhaka Cantonment, Dhaka, Bangladesh.

RESULTS

Most of the patients belonged to age group of $e^{\prime}50$ years. The mean age was 52 ± 9.1 years in phacoemulsification group and 55 ± 8.9 years in manual small incision cataract surgery (SICS) group. Men (62.50%; 70%) had a higher incidence rate than women (37.5%; 30%) in both groups. Male female ratio was 1:1.7 in Phacoemulsification group and 1:2.3 in SICS group. Statistically no significant ($P>0.05$) difference was observed in age and sex between the groups (Table-I). The mean endothelial cell count was found decreased at day 1 ($2585.07\pm 355.65/\text{mm}^2$ vs. $2598.07\pm 385.76/\text{mm}^2$), after 1 week ($2564.72\pm 347.23/\text{mm}^2$ vs. $2388.77\pm 326.46/\text{mm}^2$) and after 3 months ($2476.72\pm 346.69/\text{mm}^2$ vs. $2248.77\pm 354.47/\text{mm}^2$) following phacoemulsification and MSICS from their preoperative values ($2745.35\pm 395.27/\text{mm}^2$ vs.

$2673.04\pm 388.28/\text{mm}^2$) respectively. However, no significant difference was observed in mean endothelial cell count of both groups ($P>0.05$) (Table-II). We observed mean endothelial cell loss at day 1, after 1 week and after 3 months through follow-up. After 3 months, endothelial cell loss was significantly ($P<0.05$) more than preoperative value in case of phacoemulsification surgery, while in MSICS, endothelial cell loss was significantly more both after 1 week ($P<0.05$) and 3 months ($P<0.001$) as compared with preoperative values (Table-III). Mean percentage of endothelial cell loss were observed $5.84\pm 10.02\%$ and $2.80\pm 0.65\%$ at day 1, $6.58\pm 12.15\%$ and $10.63\pm 15.92\%$ at 1 week, $9.78\pm 12.29\%$ and $15.87\pm 8.71\%$ at 3 months after phacoemulsification and MSICS. Statistically no significant ($P>0.05$) difference was observed in percentage of endothelial cell loss of both groups.

Table-I: Distribution of study subjects according to age and gender (N=80)

	Phacoemulsification (n=40)	MSICS (n=40)	P value
Age (Years)			
<50	17 (42.5%)	13 (32.5%)	0.356 ^{NS}
≥ 50	23 (57.5%)	27 (67.5%)	
Mean \pm SD	52 \pm 9.1	55 \pm 8.9	
Sex			
Male	25 (62.50%)	28 (70%)	0.478 ^{NS}
Female	15 (37.50%)	12 (30%)	
Ratio	1:1.7	1:2.3	

Data were expressed as frequency, percentage and Mean \pm SD. Chi-Square test was performed to compare between the groups. NS=not significant.

Table-II: Mean endothelial cell count of the study subjects at different follow-up (N=80)

Follow-up	Phacoemulsification (n=40) (Cells/ mm^2)	MSICS (n=40) (Cells/ mm^2)	P value
Pre-operative	2745.35 \pm 395.27	2673.04 \pm 388.28	0.988 ^{NS}
Post-operative			
Day 1	2585.07 \pm 355.65	2598.07 \pm 385.76	1.000 ^{NS}
After 1 week	2564.72 \pm 347.23	2388.77 \pm 326.46	0.375 ^{NS}
After 3 months	2476.72 \pm 346.69	2248.77 \pm 354.47	0.097 ^{NS}

Data were expressed as Mean \pm SD. Unpaired student's t test was performed to compare between the groups. NS=not significant.

Table-III: Mean endothelial cell loss after surgery at different follow-up (N=80)

Follow-up	Phacoemulsification (n=40)		MSICS (n=40)	
	Cell loss (Cells/ mm^2)	P value	Cell loss (Cells/ mm^2)	P value
Day 1	160.28 \pm 39.62	0.502 ^{NS}	74.97 \pm 2.52	0.984 ^{NS}
After 1 week	180.63 \pm 48.04	0.340 ^{NS}	284.27 \pm 61.82	<0.05 ^S
After 3 months	268.63 \pm 48.58	<0.05 ^S	424.27 \pm 33.81	<0.001 ^S

Data were expressed as Mean \pm SD. Paired student's t test was performed to compare pre and postoperative values of each group. NS=not significant, S=significant.

Table-IV: Postoperative mean percentage of endothelial cell loss (N=80)

Follow-up	Phacoemulsification (n=40)(%)	MSICS (n=40) (%)	P value
Day 1	5.84±10.02	2.80±0.65	0.820 ^{NS}
After 1 week	6.58±12.15	10.63±15.92	0.570 ^{NS}
After 3 months	9.78±12.29	15.87±8.71	0.137 ^{NS}

Data were expressed as Mean±SD. Unpaired student's t test was performed to compare between the groups. NS=not significant.

DISCUSSION

In the present study, most of the patients belonged to age group of e"50 years. Mean±SD age was 52±9.1 years in phacoemulsification group and 55±8.9 years in manual small incision cataract surgery (MSICS) group. Men (62.50%; 70%) had a higher incidence rate than women (37.5%; 30%) and male female ratio was 1:1.7 in Phacoemulsification group and 1:2.3 in MSICS group. Participants were matched by age and gender. Almost similar findings were observed by various researchers of different countries.^{11,12}

Our study showed that the mean endothelial cell count was decreased at day 1, after 1 week and 3 months after Phacoemulsification and SICS from preoperative value. Statistically no significant (P>0.05) difference was observed in mean endothelial cell count between the groups. However, at final follow-up of 3 months endothelial cell loss was found significantly more after phacoemulsification and 1st week and 3 months after MSICS than their preoperative values respectively. Mean percentage of endothelial cell loss was observed as increased after both Phacoemulsification and MSICS from preoperative value. Our results were concomitant with study conducted by various researchers of different countries.¹³⁻¹⁹

There are two possible explanations for the discrepancy between the results. First, the design of the study, which included multiple surgeons performing cataract surgeries, could be pointed out as a weakness of this research. Nevertheless, it might also be considered one of the strengths, because the inclusion of the results from different cataract surgeons can provide information helps in generalizability to a larger group of patients.

CONCLUSION

To summarize, a significant change was observed in corneal endothelial cell counts after both phacoemulsification with PCIOL and MSICS with PCIOL. A postoperative decrease in endothelial cell

count from its preoperative value was observed in both procedures. However, the difference was not statistically significant between the procedures. A large-scale study is recommended to reproduce the findings of this study and make those generalizable to the reference population.

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