ORIGINAL ARTICLE

Comparison of Endothelial Cell Loss by Specular Microscopy between Phacoemulsification and Manual Small-Incision Cataract Surgery

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ABSTRACT

Aim: To compare the endothelial cell loss between phacoemulsification and manual small-incision cataract surgery (SICS). Endothelial cell loss was also compared in phacoemulsification group by temporal clear corneal incision (CCI) and by superior scleral incision (SI) technique. **Materials and Methods:** A total of 200 eyes of 200 patients were included in the study. Cases were randomly divided into two equal groups. Group A had undergone phacoemulsification and Group B had under gone manual SICS. In Group A 50 cases were performed by temporal CCI and remaining 50 cases were performed by superior SI technique. Endothelial cell count was evaluated by using a noncontact specular microscope. **Results:** Mean endothelial cell loss (cells/mm^2) in Group A was 307.80 (12.33%), 397.79 (15.93%), and 421.69 (16.89%) on 1 week, 6 week, and 3 month postoperative period, respectively. In Group B, it was 270.86 (10.63%), 385.22 (15.12%), and 413.68 (16.24%) on 1 week, 6 week, and 3 month postoperative period, respectively. There was no clinical and statistically significant difference ($P > 0.05$) between the two groups. The mean endothelial cell loss in Group A by CCI was 340.68 (13.61%), 427.80 (17.08%), and 448.70 (17.92%) and by SI was 274.92 (11.05%), 367.78 (14.78%), and 394.68 (15.83%) on 1 week, 6 week, and 3 month postoperative period respectively. There was statistically significant difference in endothelial cell loss at 1 week ($P < 0.05$) but it was not statistically significant on 6 week and 3 month postoperatively ($P > 0.05$). **Conclusion:** There was no clinically or statistically significant difference in endothelial cell loss or visual acuity between phacoemulsification and manual SICS at 3 month postoperative period.

Keywords: Endothelial cell count, manual small incision cataract surgery, phacoemulsification, specular microscope

INTRODUCTION

Cataract extraction is one of the most common surgical procedures performed in ophthalmology. It is also one of the most cost-effective interventions in terms of disability-adjusted life years saved and quality of life restored.[1,2] Providing Early Childhood Care and Education (ECCE) to 95% of those who need it (95% coverage level) would avert more than 3.5 million disability-adjusted life years per year globally.[2] Some degree of endothelial cell loss is inevitable after any type of cataract surgery.[3,4] The number and the integrity of corneal endothelial cells are the two important factors in maintaining corneal transparency. The mean endothelial cell count (ECC) in a normal

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Access this article online

Quick Response Code

Website:
www.nigerianjournalofophthalmology.com

DOI:
10.4103/0189-9171.170991

adult cornea ranges from 2000 to 2500 cells/mm², and the count continues to decrease with age. Other factors contributing to decreased ECC include endothelial abnormalities, such as Fuchs dystrophy, corneal guttata, and iridocorneal endothelial syndrome. Another important cause of a decrease ECC is trauma from cataract surgery. Clinical observations indicate than an ECC of 400–600 cells/mm² is a crucial point at which endothelial decompensation develops. Therefore ECC is clinically an important parameter.[5,6] The proponents of manual small-incision cataract surgery (SICS) and phacoemulsification cataract surgery claims similar good results.[7-9] However, SICS costs much less than phacoemulsification.[9-11] There is concern that manual SICS may be more harmful to the endothelium than phacoemulsification because most manipulation is performed manually in the anterior chamber (AC); in phacoemulsification, manoeuvring is mechanical and performed in the capsular bag, relatively far from endothelium. Significant loss of endothelium can lead to corneal decompensation and loss of corneal clarity.[3,4]

In India, approximately 5 million cataract surgeries are performed per year; therefore, it is important to determine which technique is safest to the endothelium.[9,10]

MATERIALS AND METHODS

This is a randomized prospective observational follow-up (longitudinal) study of 200 patients, assigned to undergo cataract surgery by phacoemulsification or manual SICS with a posterior chamber intraocular lens (PCIOLs) implantation. Each group had 100 cases. It was randomly decided which patient will undergo phacoemulsification and manual SICS. Study was done from July 2012 to September 2014 at Dr. D. Y. Patil Hospital and Research Center Pune. Ethical Committee approval was achieved before starting the study.

Patients admitted above the age of 45 years with Grade I–III nuclear cataract, PSC and cortical were included in the study. Complicated cataract, presenile cataract, black cataract, traumatic cataract, patients with diabetes mellitus, cataract associated with glaucoma, uveitis, zonular dehiscence tumor, pterygium, corneal opacity, acute infection, severe inflammation, preoperative ECC of <2000 cells/mm², retinal pathology, pseudoexfoliation and those under gone C3R or LASIK were excluded in the study. Eyes which have undergone previous ocular surgery like scleral tear repair, retinal detachment bulking surgery, glaucoma surgery, squint or corneal suturing were also excluded. After fulfilling above criteria, written informed consent was obtained from all patients. Group A comprised 100 patients, out of which 50 patients underwent phacoemulsification

with poly methyl meth acrylate (PMMA) PCIOL implantation via temporal clear corneal incision (CCI) and remaining 50 patients via superior scleral incision (SI). Group B comprised 100 patients who underwent SICS with PMMA PCIOL implantation. The SICS, phacoemulsification via scleral tunnel and phacoemulsification via temporal CCI were performed by three different experienced surgeons. Dr. A Lune performed phacoemulsification via temporal CCI and Dr. R Magdum and Dr. O K Radhakrishnan performed SICS and phacoemulsificaton via superior SI. Patients devision was performed by double blinded randomization.

Preoperative evaluation

Endothelial cell count was performed using TOPCON SP 3000P specular microscope serial number 0311215. TOPCON SP 3000P is a noncontact specular microscope. Fixed frame analysis method was used to capture the central area of cornea. Wider auto alignment simplifies the capturing procedure. The auto tracking system then takes over an area of 8 mm × 8 mm with precise focusing and centering obtained automatically. The captured image was then transferred to the computer where the Cell Count Software (TOPCON SP 3000P specular microscope) provided a highly precise analysis of the endothelial cell layer. Cases in which complication occurred during and after surgery were excluded from this study. Complications which occurred during the surgery were premature entry in AC, rupture of posterior capsule when PCIOL were not implanted in the bag. Postoperative complications were leaking incisions and malposition of the PCIOLs.

Surgical technique

All cases were carried out under local peribulbar anesthesia. Under all aseptic precautions the eye to be operated was painted with 10% povidone iodine (for skin) and was draped. Eyelids were retracted with wire speculum and one drop of 5% povidone iodine was instilled in the conjunctival cul-de-sac. A bridle suture was passed through the superior rectus.

Phacoemulsification via temporal clear corneal incision

A clear corneal groove of 5.5 mm was made with 15 no blade from 8 to 10 o' clock and 2 to 4 o' clock for right and left eye, respectively. By depressing the portions of the lips of the groove, the point of the keratome or crescent was slid into the external incision 2.5 mm in the clear cornea. At this point, AC entry was carried out with 2.8 or 3.2 mm keratome and a side port was made with a side port blade of 15°. Corneal tunnel was triplanar and had self-sealing property. After entering the AC, visco-elastic was injected in AC. Continuous

curvilinear capsulorhexis (CCC) was done with 26 gauge bent needle. Hydrodissection was performed using ringer lactate solution. The nucleus was freely rotated and removed by phacoemulsification with stop and chop technique. The cortical matter was aspirated using a classical simcoe cannula. Viscoelastic was injected in the AC and the wound was extended with the keratome of 5.5 mm. A 5.25 mm optic, PMMA, IOL was implanted in the bag in all cases. Viscoelastic was washed off and AC was formed with ringer lactate solution. Side port opening were sealed by stromal hydration. Main incision site was also sealed with classical stromal hydration. The corneal lip hydration helped in self-sealing of the wound (no SC was given). Eye drop moxifloxacin 0.3% was instilled in conjunctival sac. Eye pad was applied.[11]

Phacoemulsification via superior scleral incision
A fornix based conjunctival flap was made superiorly with corneoscleral scissors and hemostasis was achieved with wet field bipolar cautery. A 6 mm straight incision was made on the sclera from 11 o' clock to 2 o' clock with a 15 no. blade 2 mm posterior to the corneal vascular arcade. A sclero-corneal tunnel was constructed using a crescent knife and dissection continued 1 mm into clear cornea. A side port entry was made 2–3 clock hours away from the primary incision. Viscoelastic was injected through the side port to form the AC. A capsulotomy was carried out by CCC technique with 26 gauge bent needle. At this point, AC entry was made with a keratome 3.2 mm. Hydrodissection was performed with ringer lactate solution. Phacoprobe inserted through the superior sclera-corneal tunnel. Nucleus was removed by phacoemulsification with stop and chop technique. The remaining cortical matter was aspirated using a classical simcoe cannula. Viscoelastic was injected in the AC and the inner opening of the tunnel was extended parallel to limbus up to periphery using the 5.5 mm blunt-tip keratome. A 6.0 mm optic, PMMA, IOL was implanted in the bag in all cases. Viscoelastic was washed off and AC was formed with ringer lactate. Side port and main port hydration was performed. Conjunctiva and Tenon's capsule were reposited to cover the wound and cauterized. Subconjunctival gentamycin (20 mg) and dexamethasone (2 mg) injection were given. Eye drop moxifloxacin 0.3% was instilled in the conjunctival sac. Eye pad was applied.[5]

Manual small incision cataract surgery
Initial steps were similar to phacoemulsification via superior SI till CCC. Anterior chamber was entered from the anterior limit of sclera-corneal tunnel using a 3.2 mm entry keratome. The inner opening of tunnel was extended parallel to limbus up to periphery using

the same 5.2 mm blunt-tip keratome. Hydrodissection and hydrodelineation was performed. Nucleus prolapsed into AC and delivered using either sandwich technique, viscoexpression or with the help of wire vectis. Cortical matter was aspirated using a classical simcoe cannula. A 6.0 mm optic, PMMA, IOL implanted in the bag in all cases. Viscoelastic was washed off and AC was formed with ringer lactate. Side port opening was sealed by stromal hydration. Conjunctiva and Tenon's capsule were reposited to cover the wound and cauterized. Subconjunctival gentamycin (20 mg) and dexamethasone (2 mg) injection were given. Eye drop moxifloxacin 0.3% was instilled in conjunctival sac. Eye pad was applied.

Postoperative assessment
Postoperatively, assessment was performed at 1 week, 6 week, and at 3 months. At each visit - visual acuity, anterior segment slit lamp examination, fundoscopy, and specular microscopy was pewrformed to evaluate the corneal endothelium. All patients were followed without dropout for 3 months. Data analysis was carried out using the Statistical Package for the Social Science, version 17 for windows (IBM). Chi-square test was used to find significance among the gender, cataract, pre- and post-operative visual acuity in the study group. Z-test was used to find significant difference of ECC and endothelial cell loss in the study group. A probability value of 0.05 was accepted as the level of statistical significance. $P < 0.05$ was considered statistically significant.

RESULTS

In this study 200 eyes of 200 patients were included that underwent cataract surgery. They were categorized as follows:

Group A: 100 eyes underwent phacoemulsification (50 eyes with temporal CCI and 50 eyes with superior SI).
Group B: 100 eyes underwent manual SICS.

The mean age of the participants was 62.46 ± 8.71 years in Group A, and 63.78 ± 8.36 years in Group B. Group A had 44 male patients and 56 female patients. Group B had 47 male patients and 53 female patients. There was no statistically significant difference in demographic variables (e.g. age, sex) between Group A and Group B. Both groups had maximum cases of IMSC than MSC cases. Group A had 86 cases and Group B had 82 cases of IMSC.

Table 1 shows comparison of BCVA at pre- and post-operative at 3 month between Group A and Group B. The BCVA of 6/18 or better at 3 months in Group A was 95% and in Group B was 94%.

Table 2 shows comparison of mean ECC and cell loss at pre- and post-operative at 1 week, 6 week and 3 month between Group A and Group B. The mean pre-operative ECC in Group A was 2497.07 ± 262.32 cells/mm² and in Group B was 2547.67 ± 249.29 cells/mm². There was no statistically significant difference in endothelial cell loss at 1 week, 6 week, and 3 month follow-up between the two groups ($P > 0.05$).

Table 3 shows comparison of mean ECC and cell loss at pre- and post-operative at 1 week, 6 week, and 3 month between CCI and SI in Group A. The mean endothelial cell loss at 1 week in CCI group was 340.68 ± 165.69 (13.61%) and in SI group was 274.92 ± 155.77 (11.05%) which showed a statistically significant difference ($P < 0.05$). But there was no statistically significant difference between CCI and SI group at 6 week and 3 month follow-up ($P > 0.05$).

DISCUSSION

Cataract surgery, the most commonly performed surgery, has always been associated with damage to the

corneal endothelium, the layer is so vital for keeping the cornea transparent. The response and effect of stress and trauma of cataract surgery on endothelial cell could not have been so well documented if it was not for the advent of specular microscopy.[12]

In the developing world, manual small-incision technique is gaining popularity as quick, relatively inexpensive techniques for high volume cataract management. It has been shown that phacoemulsification is safe for the corneal endothelium.[8,13,14] The result in our study shows that manual SICS is as safe for the corneal endothelium as phacoemulsification.

Studies done by Ruit *et al*. and Gogate *et al*. have shown that the postoperative visual acuity were the same for phacoemulsification and SICS.[5,7] In our study, 189 (94.5%) of 200 patients evaluated at 3 month had a BCVA better than 6/18 and the postoperative visual acuity results were similar between the two groups.

Alteration in corneal endothelium is considered an important parameter of surgical trauma and essential for estimating the safety of the surgical technique.[15] Disruption of corneal endothelial function after cataract surgery results in corneal edema, decreased cell density, and hexagonal cell change, although the return to the normal state is rapid in most cases. The time of recovery depends upon many factors such as surgical technique, type of irrigating fluid, viscoelastics, and IOL.

Elvira *et al*. have discussed the various causes of endothelial loss after surgery. These include contact with instruments, lens nucleus, lens fragments, air bubbles, IOL's, AC fluctuation, phaco-energy, duration and any

Table 1: Comparison of BCVA at preoperative and 3 months postoperative between Group A and Group B

Visual acuity	Group A		Group B	
	Preoperative	Postoperative 3 months	Preoperative	Postoperative 3 months
6/6 to 6/18	24	95	18	94
6/24 to 6/60	53	5	52	6
<6/60	23	0	30	0
Total	100		100	

BCVA: Best-corrected visual acuity

Table 2: Comparison of mean ECC and cell loss at preoperative and postoperative at 1 week, 6 weeks and 3 months between Group A and Group B

	Preoperative	Postoperative					
		1 week		6 weeks		3 months	
	ECC (cells/mm²)	ECC (cells/mm²)	Cell loss (%)*	ECC (cells/mm²)	Cell loss (%)*	ECC (cells/mm²)	Cell loss (%)*
Group A	2497.07	2189.27	307.80 (12.33)	2099.28	397.79 (15.93)	2075.38	421.69 (16.89)
Group B	2547.67	2276.81	270.86 (10.63)	2162.45	385.22 (15.12)	2133.99	413.68 (16.24)

*$P > 0.05$ at 1 week, 6 weeks and 3 months. ECC: Endothelial cell count

Table 3: Comparison of mean ECC and cell loss at preoperative and postoperative at 1 week, 6 weeks and 3 months between CCI and SI in Group A

	Preoperative	Postoperative					
		1 week		6 weeks		3 months	
	ECC (cells/mm²)	ECC (cells/mm²)	Cell loss (%)*	ECC (cells/mm²)	Cell loss (%)*	ECC (cells/mm²)	Cell loss (%)*
CCI ($n=50$)	2504.90	2164.22	340.68 (13.61)	2077.10	427.80 (17.08)	2056.20	448.70 (17.92)
SI ($n=50$)	2489.24	2214.32	274.92 (11.05)	2121.46	367.78 (14.78)	2094.56	394.68 (15.83)

*$P < 0.05$ at 1 week, $P > 0.05$ at 6 weeks and 3 months. ECC: Endothelial cell count, CCI: Clear corneal incision, SI: Scleral incision

other predisposing factors. Endothelial loss in a given case also depends upon the method used for nucleus management.[16] Endothelial cell density decreases at a greater rate than in healthy and un-operated corneas, after cataract surgery. There is a wide variation in endothelial cell loss between the various studies even when the mode of surgery is same (e.g. SICS). This is due to various factors including, different inclusion and exclusion criteria, different method of nucleus management, different type of irrigating solution and viscoelastics.[15]

A reduction of 10% in endothelial cell was reported in a study comparing phacoemulsification and ECCE.[8] In a study comparing endothelial cell loss after conventional ECCE, manual SICS and phacoemulsification, the ECC decreased by 4.72%, 4.21%, and 5.41%, respectively, with no significant difference between the three groups.[13] Another study conducted by Gogate *et al*. comparing endothelial cell loss between phacoemulsification and MSICS in 200 patients showed the mean cell loss at 6 week postoperatively was 15.5% and 15.3%, respectively, with no statistically significant difference between the two groups.[5]

The above result was comparable to our study which showed decrease in cell density of 15.93% in phacoemulsification group and 15.12% in SICS group at 6 week. At 3-month, the decrease in cell density was 16.89% and 16.24%, respectively, with no statistically significant difference between the two groups.

In our study we also compared endothelial cell loss in phacoemulsification by CCI and SI technique and found out that the mean % cell loss at 1 week was 13.61% and 11.05% respectively, which was statistically significant ($P < 0.05$). But on 6 week and 3 month follow-up the mean % cell loss in CCI and SI technique were 17.08% and 14.78%; 17.92%, and 15.83%, respectively, with no statistical significance between the two techniques.

Our results co-relates well with the study conducted in Italy[17] which compared endothelial cell damage between scleral tunnel incision and CCI. In their study they concluded that the scleral tunnel led to less postoperative endothelial cell damage than clear corneal tunnels.

The shortcoming of this study was that only one technique of phacoemulsification was compared, other technique may give different results. In addition, stainless steel blades were used instead of diamond knives and HPMC 2% was used and sodium hyaluronate 1.4% (Healon GV) was not used.

CONCLUSION

Despite the advances with modern technology in the treatment of cataract, the greatest challenge in our field continues to be large and increasing backlog of cataract blindness in developing countries. Now-a-days cataract surgeries are classified as refractive surgery with increasing expectation from patient. Manual SICS costs much less than phacoemulsification. Significant loss of endothelial cell in any cataract surgery can lead to corneal decompensation and loss of corneal clarity, therefore it was necessary to know which surgical technique will be safer in view of endothelial cell loss and visual acuity. In our study at 3 month postoperative period there was no clinically or statistically significant difference in endothelial cell loss or visual acuity between phacoemulsification and manual SICS. As manual SICS is economical and less dependent on technology than phacoemulsification, it may be the appropriate surgical procedure for treatment of cataract in the developing world. Proper case selection, diligent surgery, and adequate postoperative care are essential to maintain a clear cornea.

Conflicts of interest
There are no conflicts of interest.

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