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A comparative study of endothelial cell loss in cataract surgery: small incision cataract surgery versus phacoemulsification

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Abstract

Aim: The purpose of the study was to study and compare the endothelial cell loss in small incision cataract surgery and phacoemulsification.

Materials and Methods: A total of 200 cases were randomly selected and were divided in two groups with 100 cases in each group. In group 1, patients who underwent small incision cataract surgery were included and in group 2, patients who underwent phacoemulsification were included. The endothelial cell count was measured by noncontact specular microscope preoperatively and postoperatively on day 1, day 7, day 28 and on day 42.

Results: Mean endothelial cell loss (cells/mm^2) in group 1 was 165.81 (6.60%), 274.03 (10.95%), 359.16 (14.41%), 427.51 (17.17%) on day 1, day 7, day 28, day 42 respectively. In group 2, mean endothelial cell loss (cells/mm^2) was 205.24 (8.22%), 326.81 (12.96%), 418.36 (16.64%), 494.04 (19.53%) on day 1, day 7, day 28, day 42 respectively and the difference was statistically insignificant between the two groups at different postoperative intervals ($p > 0.05$). At 6 weeks in group 1, 97 (97%) cases have postoperative best corrected visual acuity of more than 6/18 compared to 98 (98%) cases in group 2 which was statistically insignificant (p value > 0.05).

Conclusion: The difference in endothelial cell loss and best corrected visual acuity at 6 weeks was not statistically significant between the two groups.

Keywords: Endothelial cell count, Phacoemulsification, Small incision cataract surgery, Specular microscope.

Introduction

The corneal endothelium is made up of regularly arranged polygonal cells most of which are hexagonal. The normal cornea is expected to have 60% of endothelial cells as hexagonal.(1) The normal endothelial count ranges from 2000-2500 cells/mm^2 in a normal adult and the cell count decreases throughout the life at an average of 0.6% per year.(2-4)A minimum of 400-500 cells/mm^2 is required to sustain the pumping activity of the endothelium.The corneal endothelium has limited capacity to regenerate so when endothelial cells are damaged due to surgical trauma, diseases or aging, the adjacent cells enlarge to maintain the continuity of the layer. This leads to significant cell enlargement, change in the cell density and morphology.

Cataract is a leading cause of avoidable blindness in the world, with three quarters of blindness occurring in the developing countries because of this.(5)Cataract surgery is one of the cost efficacious interventions in terms of disability adjusted life years preserved and restoration of life's quality.(6,7)Although efforts are made to preserve the corneal endothelium during surgery inspite of that in every intraocular surgical procedure the endothelium is likely to get damaged which lead to corneal decompensation and corneal haze in significant number of cases.(8,9) Some ophthalmologists believe that the difference in endothelial cell loss in small incision cataract surgery (SICS) and phacoemulsification is not significant where as others have reported in their studies that there is very less cell loss in phacoemulsification. Hence, this study is an attempt to study and compare the endothelial cell loss in these two commonly performed cataract extraction procedures.

Materials and Methods

This was a prospective randomized study of 200 cases visiting the Regional Institute of Ophthalmology, Govt. Medical College, Amritsar. The patients were randomly selected and divided in two groups, group 1 and group 2 with 100 cases in each group. In group 1 patients who underwent small incision cataract surgery were included and in group 2 patients who underwent phacoemulsification were included. This study was conducted after taking permission from ethical committee of Govt. Medical College, Amritsar. A written informed consent was taken in patient's vernacular language. The research methodology followed the guidelines in declaration of Helsinki. The technique used in small incision cataract surgery and phacoemulsification met the accepted standards worldwide.

Patients with senile cataract irrespective of age and sex, patients medically fit for cataract surgery under local anaesthesia, patients with normal corneal endothelium were included in the study. Patient with presenile cataract, traumatic cataract, any corneal disease e.g. corneal dystrophy, corneal degenerations etc., endothelial cell count of less than 1500 cells/mm^2 preoperatively, past history of corneal or intraocular surgery, ocular diseases like glaucoma, uveitis, dry eyes etc., those who were unwilling to give informed consent, intraoperative complications i.e. posterior capsular rupture, vitreous loss, cortex in the vitreous and postoperative complications i.e. leaking incisions and malposition of intraocular lens were excluded from the study. Grading of the cataract was not taken in to consideration in patient allotment to surgical technique. It was ensured that same concentration of balanced salt solution, blue dye, viscoelastics and same type of posterior chamber intraocular lens was used in all the surgeries of group 1 and group 2 cases. The outcome measures were preoperative and postoperative endothelial cell count at day 1, day 7, day 28, day 42, percentage endothelial cell loss at day 1, day7, day 28, day 42 , best corrected visual acuity at 6 weeks.

Specular Microscopy: Specular microscopy was done using TOPCON SP 3000P specular microscope. The endothelial cells were analysed using manual frame technique in which 50 cells were counted to obtain the cell count.

Surgical technique: After the peribulbar anesthesia using 2 ml of 0.5% bupivacaine and 4 ml of 2% lignocaine with 1: 200000 adrenaline mixed with 150 IU of hyaluronidase, the periocular skin was cleaned with 10% povidone iodine solution and diluted povidone iodine solution 5% was instilled in the conjuctival sac to get the antisepsis.

Small Incision Cataract Surgery (SICS): A fornix based conjuctival flap was made. A 6 mm scleral incision was made with 300 micron limited depth blade. Sclerocorneal tunnel was made up to 1 mm of clear cornea using crescent blade. Side port incision was given with 1.2 mm side port blade at 9 o'clock position. Anterior chamber was entered with 2.8 mm keratome blade and anterior capsule was stained with trypan blue dye. After filling the anterior chamber with viscoelastic continuous curvilinear capsulorrhexis was performed using 26 gauge cystitome. Sclerocorneal incision was enlarged by making side pouch incision on either side. Hydrodissection was done using balanced salt solution. Anterior chamber was refilled with viscoelastic and nucleus was prolapsed in to the anterior chamber. Viscoexpression of the nucleus was done and the remaining lens matter was cleaned with reverse simcoe cannula. Intraocular lens was implanted inside the capsular bag. Anterior chamber was formed with balanced salt solution and conjunctiva was reposited back over the sclerocorneal incision. A subconjuctival injection of 0.3 ml, 10 mg gentamicin and 2 mg dexamethasone was given. Same surgical steps of small incision cataract surgery were followed in each of the cases of group 1.

Phacoemulsification: A clear corneal incision was made with 2.8 mm keratome blade. Two side port incisions were given with 1.2 mm side port blade. Anterior capsule was stained with trypan blue dye. After filling the anterior chamber with viscoelastic, continuous curvilinear capsulorrhexis was done using 26 gauge cystitome. Hydrodissection and hydrodelineation was done. Nucleus was rotated and then emulsified with ultrasonic tip. The remaining cortical matter was cleaned using bimanual irrigation and aspiration cannula. Foldable lens was implanted inside the capsular bag. Anterior chamber was formed with balanced salt solution. A subconjuctival injection of 0.3 ml, 10 mg gentamicin and 2 mg dexamethasone was given. Same surgical steps of phacoemulsification were followed in each of the cases of group 2.

Data analysis was performed using statistical package for the social sciences, version 21.0 for windows (IBM corp. SPSS, 2012, Armonk, NY). The statistical test used to find the difference among the number of cases in different age group, gender, postoperative best corrected visual acuity at 6 weeks was chi-square test and student's unpaired sample t- test for difference in endothelial cell count and percentage endothelial cell loss at different time intervals in both the groups. $P < 0.05$ was considered to be statistically significant.

Results

200 cases were randomized to 2 groups with 100 cases in each group. Group 1 patients underwent small incision cataract surgery and group 2 patients underwent phacoemulsification. The mean age was 59.01±10.57 in group 1 and 57.25±9.61 in group 2. 101 (50.5%) cases were males and 99 (49.5%) cases were females. The demographic variables i.e. age and sex were not statistically significant between the 2 groups (p value > 0.05).

The mean preoperative endothelial cell count in group 1 was 2476.72±346.69 cells/mm^2. Postoperatively on day 1, the mean endothelial cell count was 2310.91 ± 332.82 cells/mm^2. On day 7 it was reduced to 2202.69 ± 335.65 cells/mm^2 and on day 28 the cell count was 2117.56 ± 332.28 cells/mm^2. On day 42 the mean cell count was reduced to 2049.21 ± 344.78 cells/mm^2. In group 2 the mean preoperative endothelial cell count was 2502.70 ± 329.87 cells/mm^2. Postoperatively on day 1 the mean endothelial cell count was 2297.46 ± 370.26 cells/mm^2. On day 7 the cell count was 2175.89 ± 376.19 cells/mm^2 and it was reduced to 2084.34 ± 382.06 cells/mm^2 on day 28. On day 42 the mean endothelial cell count was 2008.66±382.02 cells/mm^2. The difference in mean endothelial cell count was not statistically significant at different postoperative intervals in both the groups (p>0.05). (Table 1)

In group1 postoperatively, the mean endothelial cell loss was165.81 ± 147.52 cells/mm^2, 274.03 ± 189.27, 359.16 ± 198.69, 427.51 ± 229.67 cells/mm^2 on day 1, day 7, day 28, day 42 respectively while in group 2 postoperatively, there was loss of 205.24 ± 200.47 cells/mm2 on day 1which was increased to 326.81 ± 265.94, 418.36 ± 287.28, 494.04 ± 328.57 cells/mm^2 on day 7, day 28, day 42 respectively. The difference in mean endothelial cell loss was not significant at different postoperative intervals in both the groups ($p > 0.05$). (Table 2)

Postoperatively on day 1 the percentage cell loss was 6.6% in group 1 compared to loss of 8.2% in group 2. On day 7 the mean percentage endothelial cell loss was increased to 10.95% in group 1 compared to loss of 12.96% in group 2. On day 28 the percentage cell loss further increased to 14.41% in group 1 and to 16.64% in group 2 .The mean percentage endothelial loss was 17.17% in group 1 and 19.53% in group 2 on day 42 postoperatively.The percentage endothelial cell loss was more in group 2 in comparison to group 1 in all the postoperative intervals but there was no statistically significant difference between the two groups ($p > 0.05$). (Table 3) (Fig. 1)

In group 1, 97 (97%) cases had postoperative best corrected visual acuity at 6 weeks better than 6/18 compared to 98 (98%) cases in group 2 and there was no statistically significant difference between the two groups (p value > 0.05). (Table 4)

Table 1: Mean endothelial cell count (cells/mm^2)

Groups	Preoperative mean endothelial cell count (cells/mm^2)	Postoperative mean endothelial cell count (cells/mm^2)			
		Day 1	Day 7	Day 28	Day 42
Group 1	2476.72±346.69	2310.91 ± 332.82	2202.69 ± 335.65	2117.56 ± 332.28	2049.21 ± 343.78
Group 2	2502.70±329.87	2297.46 ± 370.26	2175.89 ± 376.19	2084.34 ± 382.06	2008.66 ± 382.02
‘t’ value	-0.543	0.270	0.531	0.656	0.789
p value	0.588	0.787	0.596	0.513	0.431
Significance	Non-significant	Non-significant	Non-significant	Non-significant	Non-significant

Table 2: Postoperative endothelial cell loss (cells/mm^2)

Groups	Postoperative endothelial cell loss			
	Day 1	Day 7	Day 28	Day 42
Group 1	165.81± 147.52	274.03 ± 189.27	359.16 ± 198.69	427.51 ± 229.67
Group 2	205.24 ± 200.47	326.81 ± 265.94	418.36 ± 287.28	494.04 ± 328.57
‘t’ value	1.583	1.617	1.694	1.659
p value	0.115	0.108	0.091	0.099
Significance	Non-significant	Non-significant	Non-significant	Non-Significant

Table 3: Percentage endothelial cell loss (%)

Postoperative intervals	Percentage endothelial cell loss (%)		‘t’ value	p value	Significance
	Group 1	Group 2			
Day 1	6.60	8.22	1.607	0.109	Non-significant
Day 7	10.95	12.96	1.550	0.123	Non-significant
Day 28	14.41	16.64	1.617	0.107	Non-significant
Day 42	17.17	19.53	1.555	0.121	Non-significant

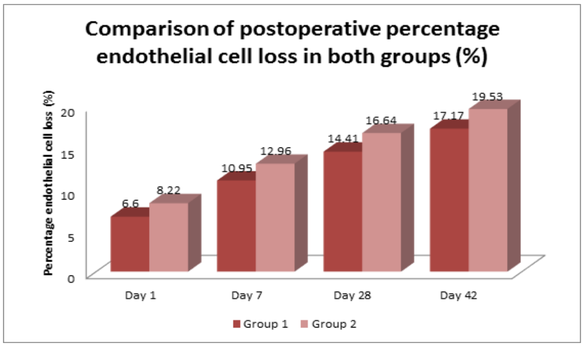

Fig. 1: Comparison of percentage endothelial cell loss (%)

Table 4: Postoperative best corrected visual acuity at 6 weeks

Best corrected visual acuity (BCVA)	Percentage of patients (%)	
	Group 1	Group 2
VA<= 6/18	3	2
VA >6/18	97	98
X^2	0.205	
Df	1	
p-value	0.651	

Discussion

The safety of phacoemulsification for corneal endothelium has been shown in many studies.[10-12]The results in our study have reported equal safety of both the small incision cataract surgery and phacoemulsification for the corneal endothelium. In the present study, postoperatively on day 1 the mean percentage endothelial cell loss was 6.6% in group 1 compared to loss of 8.22% in group 2. On day 7 the mean percentage endothelial cell loss was increased to 10.95% in group 1 compared to loss of 12.96% in group 2. On day 28 the percentage cell loss was further increased to 14.41% in group 1 and to 16.64% in group 2. The mean percentage endothelial loss was 17.17% in group 1 and 19.53% in group 2 on day 42 postoperatively. The percentage endothelial cell loss was more in group 2 than in group 1 at all the postoperative intervals but the difference was not statistically significant (p value > 0.05).

A study conducted to study the effect of conventional extracapsular cataract extraction and phacoemulsification on the corneal endothelium reported an average 10% cell loss in both the groups.[10]Another study conducted to study the endothelial cell loss reported a cell loss of 4.72% (SD:13.07) in extracapsular cataract extraction, 4.21% (SD: 10.29) in small incision cataract surgery, 5.41% (SD:10.99) and there was no significant difference in endothelial cell loss between the three groups.[11]A study conducted to compare the endothelial cell loss at 6 weeks between phacoemulsification and manual small incision cataract surgery reported the mean percentage endothelial cell loss of 15.5% in phacoemulsification and 15.3% in manual small incision cataract surgery with statistically insignificant difference between the two groups.[13] Similar results were seen in another study conducted to compare the endothelial cell loss in small incision cataract surgery and phacoemulsification which reported a mean percentage cell loss of 14.68% in small incision cataract surgery and 16.26% in phacoemulsification and the difference was not statistically significant.[14]

The results of our study were comparable to a study conducted to compare the endothelial cell loss in phacoemulsification and small incision cataract surgery which showed a decrease in percentage endothelial cell loss of 15.93% in phacoemulsification group and 15.12% in small incision cataract surgery group at 6 weeks and 16.89% and 16.24%respectively at 3 month and the difference was not statistically significant.[15] The higher cell loss in our study was due to the reason that harder cataracts were not excluded from the study.

A study conducted to compare scleral tunnel incisions and clear corneal tunnel incision in terms of endothelial cell damage reported less endothelial cell damage postoperatively in scleral tunnels than clear corneal incision.[16] In our study, small incision cataract surgery was performed through the scleral tunnel incision which might have lead to less cell damage as compared to phacoemulsification in which clear corneal tunnel incision was made.

In our study in group 1, 97% patients had postoperative best corrected visual acuity at 6 weeks better than 6/18 compared to 98% patients in group 2. The difference in postoperative best corrected visual acuity was not statistically significant (p value >0.05).

Similar results were seen in a study at six months in which UCVA of 20/60 or better was seen in 89% of SICS patients compared to 85% of the phacoemulsification patients with best corrected visual acuity (BCVA) of 20/60 or better in 98% patients in both the groups and the difference was not statistically significant.[17]

In another study, the visual acuity results were similar in phacoemulsification and small incision cataract surgery in which 70 (98.5%) patients in phacoemulsification group and 73 (97.3%) patients in small incision cataract surgery group have CDVA better than 6/18 at 6 weeks.[13]

The visual acuity results were similar postoperatively between the phaoemulsification and small incision cataract surgery in another study in which 189 (94.5%) of 200 patients had a BCVA of more than 6/18 at 3 months.[15]

Conclusion

Despite of many recent advances in the field of cataract extraction, the backlog of visual impairment due to cataract is increasing in developing countries. In our study, postoperatively at day 42 the difference in endothelial cell loss and best corrected visual acuity between small incision cataract surgery and phacoemulsification was not statistically significant. Both of these surgeries are equally safe for the corneal endothelium. As the small incision cataract surgery does not depend upon advanced technology and is more economical, it may be a favourable surgical procedure in those areas where high cost advanced phacoemulsification techniques are still not available.

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