Research Paper

Volume : 5 | Issue : 4 | April 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

Comparative Study of Corneal Endothelial Changes: Manual Sics Vs Phacoemulsification

Medical Science

KEYWORDS : Endothelial Cell Count (ECC), manual SICS, phacoemulsification, specular microscopy.

*** GunjanVerma**	Tutor in Ophthalmology, Baroda Medical College, Baroda, Gujarat. * Corresponding author
Minal Patel	Assistant Professor, GMERS Medical College, Sola, Ahmedabad
Pina Soni	Associate Professor, GMERS Medical College, Sola, Ahmedabad
Deepika Singhal	Professor, GMERS Medical College, Sola, Ahmedabad
Mayur Damor	Tutor in Ophthalmology, Baroda Medical College, Baroda, Gujarat.

ABSTRACT

Aim: to assess and compare changes occurring in corneal endothelium following phacoemulsification and manual Small Incision Cataract Surgery with IOL implantation

Place and duration of study: Department of Ophthalmology, GMERS Medical College, Ahmedabad between December 2013 to May 2014.

Materials and methods: 40 consecutive patients were randomly allocated to 2 groups based on type of surgery- Group A: manual SICS (n-20) and group B: phacoemulsification (n-20) and were followed serially until 6 months. Mean age of the patients is 62.95 years±7.63 (SD) in SICS group and 64.35 years ± 7.37(SD) in phacoemulsification group. Complete Ophthalmic examination was done in form of visual acuity, slit lamp examination, IOP, corneal specular examination by Topcon sp 3000p pre operatively and post operatively at day 1, day 7, 4 weeks and 6 weeks.

Result: Total 40 patients were included in the study. , Endothelial cell density pre operatively is 2588.99 cell/mm2± 333.93(SD) and 2591 cells/mm2±400.98 (SD) in SICS and phacoemulsification group respectively. Mean cell loss at 6 weeks is 314.96 cell/mm2 ±225.55 (SD)(p=0.014) inSICS group and 347.82 cells/mm2±222.36(SD)(p=0.008) in phacoemulsification group. Both groups have significant cell loss, however no statistically significant difference in endothelial cell loss between the manual SICS group and phacoemulsification group.

Conclusion: There is no difference in safety between SICS and phacoemulsification. SICS can be sought as an alternative to phacoemulsification where trained surgeons for undertaking phacoemulsification or facilities for phacoemulsification are lacking. Proper case selection, meticulous surgery and adequate post operative carewill result in better outcome.

Financial Disclosure: NIL

INTRODUCTION

Senile cataract forms the main cause of reversible blindness in developing countries. About 20 million individuals suffer from cataract and 80% of them are in developing countries.In last few decades choice of cataract extraction has shifted from ECCE to SICS and Phacoemulsification. SICS is considered to be fast, economic and less technology dependent. Phacoemulsification (PE) with a foldable lens has become the predominant procedure to manage cataracts in developed countries[1,2].Although, the higher cost of the PE machine and disposable supplies and the requirement for more advanced surgical training have limited the use of PE in most developing world[3].In these countries, ophthalmologists are performing manual small-incision cataract surgery (MSICS) as an alternative in order to obtain the advantages of a self-sealing sutureless incision at low cost[4].

Healthy corneal endothelial cells are hexagonal in shape with numerical density of around 3000 cells/mm^2 at birth. Corneal endothelial cells maintain transparency and dehydrated state of corneal stroma by Na^+/K^+ ATPase activity by generation of bicarbonate ion gradient across the corneal endothelium[5,6,7,8]. Minimal numerical density of 400-500 cells/mm^2 is required to maintain dehydrated and transparent state of cornea, otherwise dysfunction will occur in form of corneal edema. Endothelial cells do not regenerate.[9,10,11,12]

Endothelial injury may occur during cataract surgery due to a number of factors, such as corneal distortion, ricocheting of nuclear fragments, intraocular lens (IOL) contact, and release of free radicals[13].

Specular microscopy has become a standard technique to determine endothelial cell density and morphology in vivo. Analysis of cell shape and pattern is a more sensitive indicator of endothelial damage than cell density alone[14].

Aims and objective

With recent advances in Cataract surgery, phacoemulsification with foldable intraocular lens implantation has been considered as gold standard for cataract surgery. However, the cost of machine precludes its use on a large scale in developing countries .On the other hand SICS has advantage of being sutureless with minimal investment and has been shown to have comparable to phacoemulsification in terms of endothelial cell loss and visual acuity. Present study documents and compares outcomes of surgery in terms of endothelial cell loss at 6 weeks.

Materials and methods

Study was carried out in GMERS Medical College, Sola, Ahmedabad from December 2013 to May 2014(6 months). All walk in patients with operable cataract were asked to participate. The study was approved by departmental technical review board. All the participants were informed about the nature of study and written informed consent was taken from participants prior to study. Forty eyes of 40 patients were assigned randomly in two groups, group A (n=20, underwent manual SICS), group B (n=20 underwent phacoemulsification). Mean age of 62.95 years±7.63 (SD) in SICS group and 64.35 years ± 7.37(SD) in phacoemulsification group. Participants were given choice to withdraw anytime from the study and were assured that study won't compromise the quality of their eye care.

One of the inclusion criteria was to include patients with nuclear sclerosis grade 2-3.Patients with mature or hard dense cataract, history of other intraocular disease eg. glaucoma, uveitis, pseudoexfoliation, pre existing corneal decompensation (pre op cell density less then 2000 cell per sq mm^2)or guttae, retinal diseases and who had intraoperative complication eg. posterior capsular rent, vitreous loss, DM detachment, Anterior chamber IOL implantation were excluded from the study.

Clinical and Ophthalmic examination as per standard protocol was done both pre operatively and post operatively visual acuity, slit lamp examination, IOP, corneal specular examination by Topcon sp 3000p pre operatively, post-operative day 1 (POD 1), post-operative day 7 (POD 7), post-operative after One month (PO 1 month) and post-operative after six weeks (PO 6 wks).The surgical steps were kept same for all the patients in their respective groups. Viscoelastic substance and the irrigating solution used was also same.

The outcome measures were the preoperative and 1- week and 6-week postoperative.Paired t test was used to analyzethe data. "p" value of less than 0.05 was considered to be significant.

Specular microscopy and image analysis:
The endothelial cell count was performed using Sp-3000 Topcon Specular Microscope which is a non-contact method for assessment. For the examination, the patient was seated at the appropriate height with his or her chin resting on the chin rest of the instrument. A white dot filter was used with a medium-width light beam. A joystick was used to focus the bright circular reticle on the centre of the pupil to take the endothelial photograph from the centre of the cornea. The vertical light beam was aligned adjacent to the reticle, and a foot switch was used to begin recording the photographs. If clear photographs were not obtained, the procedure was repeated. The endothelial cells were counted using automated counting of cells by the software of the specular microscope. For each eye the mean of measurements made on three micrographs was calculated.

RESULTS:
Forty patients were randomly assigned into 2 groups: group A (n=20) had undergone manual SICS and group B (n=20) had phacoemulsification.

Mean age of the patients in SICS gp was 62.95 years±7.63(SD) and 64.35 years ± 7.37(SD) in phacoemulsification group. Gender wise , twenty two (55%) patients were female while rest were males.

Table 1 narrates the comparison of endothelial sell loss, Mean Endothelial cell density pre operatively was 2588.99 cell/mm^2±333.93(SD) and 2591 cells/mm^2±400.98 (SD) in SICS and phacoemulsification group respectively.

Mean cell loss at 6 weeks was 314.96 cell/mm^2 ±225.55 (SD) in SICS group and 347.82 cells/mm^2±222.36(SD) in phacoemulsification group.

Endothelial loss was 6.8% and 12.16% (p=0.014) at 1 week and 6 weeks in manual SICS group ,whereas 7.73% and 13.42%(p=0.008)in phacoemulsification group.

In both groups p value is significant although there was no statistically significant difference in endothelial cell loss between the manual SICS group and phacoemulsification group.

Table 1- comparison of endothelial cell loss.

	Mean ECC(cells/mm^2)			Mean cell loss,n(%)	
	Pre op	Post op		post op	
Method		1 week	6 weeks	1 week	6 weeks
SICS	2588.99	2412.53	2274.03	176.46(6.8%)	314.96(12.16%)
PHACO	2591.52	2391.14	2243.7	200.38(7.73%)	347.82(13.42%)

ECC: Endothelial Cell Count
P value SICS -1 week :0.104 6 weeks:0.014
Phaco- 1 week:0.057 6 weeks: 0.008

DISCUSSION:
Cataract forms a major cause of reversible blindness especially in developing countries. In last few decades choice of cataract extraction has shifted from ECCE to SICS and phacoemulsification. SICS is now becoming popular as quick relatively inexpensive and less technology dependent. In our study we have compared endothelial safety of phacoemulsification and manual SICS in terms of changes in endothelial cell density.

Various studies have concluded phacoemulsification to be safe for the corneal endothelium[15,16,17]

Ruit et al has shown in their study that postoperative visual acuity and complication rates are the same phacoemulsification and SICS[18]

Endothelial alteration has been considered as a parameter for estimating surgical trauma and safety of a surgery. SICS technique carries greater risk of endothelial loss that is mainly attributed to surgical manipulation in the anterior chamber close to corneal endothelium and endothelial trauma during the nucleus delivery from the anterior chamber. Various modifications of SICS (irrigating vectis, viscoexpression of the nucleus, anterior chamber maintainer, high density viscoelastics) have significantly reduced the endothelial cell loss. In phacoemulsification, the maneuvering is mechanical and performed in the capsular bag , distantly from the endothelium and newer advanced phacoemulsification units with better fluidics may reduce the chances of endothelial damage.

Study conducted by Baltreme et al[20] comparing endothelial cell damage between scleral tunnel incisions and clear corneal tunnel incisions for phacoemulsification concluded that scleral tunnels led to less postoperative endothelial cell damage than clear corneal tunnels. Because SICS was performed through the scleral tunnel incision, it may have caused less endothelial cell loss than phacoemulsification performed through a clear corneal tunnel incision. The higher cell loss in the upper corneal endothelium might be caused by mechanical trauma from the phaco tip or instruments used to insert the IOL, despite the use of viscoelastic material. And scleral tunnel is more posterior and therefore induces less direct (eg, phaco tip, IOL implantation) and indirect (mechanical corneal striae) trauma. However there was no significant difference in surgically induced endothelial damage after sutureless 3.5 mm CCIs and sutured 5.5 mm CCIs.

There are number of factors which dictate endothelial cell loss during phacoemulsification surgery are turbulence of the irrigation solution[21], bubble and free-radical formation during phacoemulsification[22], mechanical trauma by instruments[23], and the presence of lens fragments[25] and IOLs[25], ultrasound energy[26], hyaluronic acid has binding sites on the endothelium and may provide mechanical and chemical protection during surgery[27]

In our study, endothelial loss was 6.8% and 12.16% at 1 week and 6 weeks respectively in manual SICS group ,whereas 7.73% and 13.42% respectively in phacoemulsification group. There is no statistically significant difference in between 2 groups. Manual SICS is as safe for the corneal endothelium as phacoemulsification, is almost as effective, and is much more economical.

The results in the literature on mean cell loss after phacoemulsification are not homogeneous. A study comparing phacoemulsification and conventional ECCE found a 10% reduction in endothelial cells in both groups.[19]

Volume : 5 | Issue : 4 | April 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

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 differences between the 3 groups.[15]

Studies have been carried out comparing endothelial cell damage after phacoemulsification and planned ECCE with different capsulotomy techniques.The mean cell loss was 11.8% in the phacoemulsification Group, 12.8% in the ECCE group in which a CCC was used, and 10.1% in the ECCE group in which a letter-box capsulotomy was used.[17]

In study conducted by Gogate et al[28],mean endothelial cell loss in phacoemulsification group to be 13.2% and 15.5% at 1 and 6 weeks respectively while in SICS it was 11.1% and 15.3% at 1 and 6 weeks. There was no statistically significant difference in endothelial cell loss between the phacoemulsification group and the SICS group.

Evaluation of the endothelial population using cell density does not completely describe the

endothelial population[29] . Since cell density does not reflect cellular polymegethism and pleomorphism, quantitative description of the cellular pattern provides additional features of the endothelium that can be complimentary to describe the endothelial population and possibly its functional status [29,30].

A prospective study from the evaluating the long-term (5 year) safety of phakic IOLs found that the rate of endothelial cell loss decreased over time. Endothelial cell loss is more likely related to corneal endothelial cell remodelling after the trauma of surgery than to ongoing age-related cell loss[31]. The increase in cells as time increases after surgery may be the result of endothelial cell renewal by corneal stemcells[32].

Lack of long term follow up and small sample size are major limitations of the study and only single techniques for phaco and SICS have been used .Adding to it, steel disposable knives are used for the study rather than diamond knives. Sodium hyaluronate 1.4% (Healon GV) was not used. Higher retaining OVDs may have resulted in lesser endothelial loss.

CONCLUSION:

Thus concluding, there is no difference in safety between SICS and phacoemulsification. SICS can be sought as an alternative to phacoemulsification where trained surgeons or facilities are lacking. Each and every case requires vigilance and proper case selection, meticulous surgery and adequate post operative care are required to obtain optimal results.

Financial Disclosure: No author has any financial or proprietary interest in any material or method mentioned.

REFERENCES:

1- Chakrabarti A, Singh S, Krishnadas R. Phacoemulsification in eyes with white cataract. *J Cataract Refract Surg*2000; **26**: 1041–7.

2-. Vasavada A, Singh R, Desai J. Phacoemulsification of white mature cataracts. *J Cataract Refract Surg*1998; **24**: 270–7.

3- Khanna R, Pujari S, Sangwan V. Cataract surgery in developing countries. *CurrOpinOphthalmol*2011; **20**: 10–4.

4- Natchiar G, DabralKar T. Manual small incision sutureless cataract surgery; an alternative technique to instrumental phacoemulsification. *Oper Tech Cataract Refract Surg*2000; **3**: 161–70.

5- Hodson S. Evidence for a bicarbonate-dependent sodium pump in corneal endothelium.*Exp Eye Res* 1971;**11**:20–9.

6- Maurice DM. The location of the fluid pump in the cornea.*JPhysiol*1972;**221**:43–54.

7- Dikstein S, Maurice DM. The metabolic basis of the fluid pumps in the cornea. *J Physiol***221**:29–41.

8- Fischbarg J, Lim JJ.Role of cations, anions and carbonic anhydrase in fluid transport across rabbit corneal endothelium.*J Physiol*1974;**241**:647–75.

9- Waring GO, Bourne WM,Edelhauser HF, *et al.* The corneal endothelium: normal and pathologic structure and function. *Ophthalmology* 1982;**89**:531–90.

10- Kaufman HE, Capella JA, Robbins JE. The human corneal endothelium.*Am J Ophthalmol*1966;**61**:835–41.

11- Capella JA. Regeneration of endothelium in diseased and injured corneas.*Am J Ophthalmol*1972;**74**:810–7.

12- Jacobs PM, Cheng H, Price NC, et al. Endothelial cell loss after cataract surgery—the problem of interpretation. Trans OphthalmolSoc U K 1982;102:291

13- Cameron MD, Poyer JF, Aust SD. Identification of free radicals produced during phacoemulsification. J Cataract Refract Surg 2001;27:463–70.

14- Matsuda M, Suda T, Manabe R. Serial alterations in endothelial cell shape and pattern after intraocular surgery.Am J Ophthalmol 1984; 98:313–319

15- George R, Rupauliha P, Sripriya AV, Rajesh PS, Vahan PV, Praveen S. Comparison of endothelial cell loss and surgically induced astigmatism following conventional extracapsular cataract surgery, manual small-incision surgery and phacoemulsification. Ophthalmic Epidemiol. 2005;12:293–7.

16- Bourne RR, Minassian DC, Dart JK, Rosen P, Kaushal S, Wingate N. Effect of cataract surgery on the corneal endothelium; modern phacoemulsification compared with extracapsular cataract surgery.Ophthalmology. 2004;111:679–85.

17- Díaz-Valle D, Benítezdel Castillo Sánchez JM, Castillo A, Sayagués O, Moriche M. Endothelial damage with cataract surgery techniques. J Cataract Refract Surg. 1998;24:951–5.

18-. Ruit S, Tabin G, Chang D, Bajracharya L, Kline DC, Richheimer W, et al. A prospective randomized clinical trial of phacoemulsification vs manual sutureless small-incision extracapsular cataract surgery in Nepal. Am J Ophthalmol. 2007;143:32–8.

19-. Bourne RRA, Minassian DC, Dart JKG, Rosen P, Kaushal S, Wingate N. Effect of cataract surgery on the corneal endothelium; modern phacoemulsification compared with extracapsular cataract surgery. Ophthalmology 2004; 111:679–685

20- Beltrame G, Salvetat ML, Driussi G, Chizzolini M. Effect of incision size and site on corneal endothelial changes in cataract surgery. J Cataract Refract Surg 2002; 28:118–225

21-. Edelhauser HF, Van Horn DL, Hyndiuk RA, SchultzRO. Intraocular irrigating solutions; their effect on thecorneal endothelium. Arch Ophthalmol 1975; 93:648–657

22 Craig MT, Olson RJ, Mamalis N, Olson RJ. Air bubbleendothelial damage during phacoemulsification in humaneye bank eyes: the protective effects of Healon andViscoat. J Cataract Refract Surg 1990; 16:597–602

23-. McCarey BE, Polack FM, Marshall W. The phacoemulsificationprocedure. I. The effect of intraocular irrigatingsolutions on the corneal endothelium. Invest Ophthalmol1976; 15:449–457

24- Binder PS, Sternberg H, Wickham MG, Worthen DM.Corneal endothelial damage associated with phacoemulsification.Am J Ophthalmol 1976; 82:48–54

25-. Roper-Hall MJ,Wilson RS. Reduction in endothelial celldensity following cataract extraction and intraocular lensimplantation. Br J Ophthalmol 1982; 66:516–517

26- Beesley RD, Olson RJ, Brady SE. The effects of prolongedphacoemulsification time on the corneal endothelium.Ann Ophthalmol 1986; 18:216–219, 222

27- Ha¨rfstrand A, Molander N, Stenevi U, et al. Evidence ofhyaluronic acid and hyaluronic acid binding sites on humancorneal endothelium. J Cataract Refract Surg 1992;18:265–269

28- Parikshit Gogate, PrachiAmbardekar, SuchetaKulkarni et al. Comparison of endothelial cell loss after cataract surgery: Phacoemulsification versus manual small-incision cataract surgery. J Cataract Refract Surg 2010; 36:247–253

29- Shaw, E.L., Rao, G.N., Arthur, E.J. andAquavella, J.V. (1978) The functionalreserve of corneal endothelium. Trans. Am.Acad. Ophthalmol. Otolaryngol. 85, 640-649

30- Rao, G.N., Aquavella, J.V., Goldberg, S.H.and Berk, S.L. (1984) Pseudophakic bullouskeratopathyRelationship to preoperativecorneal endothelial status.Ophthalmol.

31- Edelhauser HF, Sanders DR, Azar R, Lamielle H. Corneal endothelial assessment after ICL implantation; the ICL in Treatment of Myopia Study Group. J Cataract Refract Surg2004; 30:576–583

32- Whikehart DR, Parikh CH, Vaughn AV, Mishler K, Edelhauser HF. Evidence suggesting the existence of stem cells for the human corneal endothelium. Mol Vis 2005; 11:816–824.