ORIGINAL ARTICLE

CORNEAL ENDOTHELIAL CHANGES IN EYES UNDERGOING PHACOEMULSIFICATION VERSUS MANUAL SMALL INCISION CATARACT SURGERY

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ABSTRACT

Objective: To compare the changes in central corneal endothelial integrity in eyes undergoing phacoemulsification and manual small incision cataract surgery (MSICS) before and after cataract surgery and between the two surgical procedures.

Material and Methods: A randomized controlled trial was performed in the department of Ophthalmology, Hayatabad Medical Complex, Peshawar, Pakistan from July 2015 to December 2015. Patients meeting the inclusion criteria of both genders were admitted from outpatient department after complete ophthalmological examination. Central corneal endothelial cell density (ECD) was measured pre operatively by using specular microscope. Total 160 patients were randomly assigned into two groups, each group having equal number of patients (80). Group 1 patients underwent phacoemulsification, whereas MSICS was performed in group 2 patients. Postoperatively, specular microscopy was performed to measure final central corneal ECD at 6th weeks of surgery on the last follow up. The final outcome readings were measured and data was entered in proforma.

Results: In phacoemulsification group mean age was 61 years ± 1.27 SD where as in MSICS mean age was 61 years ± 1.31. SD with in phacoemulsification group 53% patients were male and 47% patients were female whereas in MSICS group 55% were male and 45% patients were female. Preoperatively mean endothelial cell density in phacoemulsification group was 2852cells/mm2with standard deviation ± 2.13 whereas in MSICS group mean endothelial cell density was 2950 cells/mm2 with standard deviation ± 2.26. Mean endothelial cell density postoperatively after 6 weeks in phacoemulsification group was 2348 cells/mm2 with standard deviation ± 2.88 whereas in MSICS group mean endothelial cell density was 2408 cells/mm2 with standard deviation ± 2.73.Mean endothelial cell loss was analyzed among two groups after 6 weeks postoperatively, 504 cells/mm^2 (17.2%) endothelial cell loss was recorded in phacoemulsification group while 542 cells/mm2 (18.4%) endothelial cell loss was recorded in MSICS group.

Conclusion: The mean corneal endothelial cell loss was slightly less in phacoemulsification as compared to MSICS.

Key Words: Corneal endothelial cell loss, Phacoemulsification, Manual small incision cataract surgery, Specular microscopy.

This article may be cited as: Sultan M, Hamza SA, Saeed N, Khan MN, Jan S. Corneal endothelial changes in eyes undergoing phacoemulsification versus manual small incision cataract surgery. J Med Sci 2017; 25: (2) 236-241.

INTRODUCTION

Cataract remains the leading cause of blindness globally, accounting for nearly half (47.8%) of worldwide blindness[1]. It is stated that all cataract surgery methods cause corneal endothelial cell loss[2]. Corneal distortion, irrigation solution turbulence, mechanical damage by instruments, nuclear fragments and intraocular lens contact can lead to corneal injury during cataract extraction surgery[3]. Phacoemulsification and manual small incision cataract surgery (MSICS) are two common techniques for cataract surgery[4]. Even though phacoemulsification technique has improved significantly, cataract surgery still involves surgical trauma. In phacoemulsification,-decrease in size of clear corneal incision has numerous benefits such as fast visual restoration with slight post-operative inflammation, lesser surgical induced corneal astigmatism and reduced iatrogenic corneal injury[2]. MSICS is less expensive than phacoemulsification. It is thought that MSICS may be more damaging

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Date Received: March 21, 2017
Date Revised: April 25, 2017
Date Accepted: June 10, 2017

to corneal endothelium than phacoemulsification because most maneuvering is done manually in anterior chamber; in phacoemulsification, the maneuvering is machine-driven and done in the capsular bag, away from the endothelium. Substantialdamage to corneal endothelium can cause corneal decompensation and decrease corneal clarity[4]. Studies report decrease in corneal ECD after phacoemulsification up to 3.10% ± 6.24 (SE) while after MSICS, it is 17.66% ± 3.65 (SE)[5].

Specular microscopy is a standard method to determine corneal endothelial cell density (ECD) and morphology in vivo because it allows a qualitative and quantitative morphometric study of corneal endothelial cells[6]. Corneal endothelial cell density is expressed in units of cells per square millimeter of corneal endothelium. The normal range of corneal ECD is 1865-3386 cells per square millimeter[7]. Numerous morphological features of the endothelium are vital for evaluating the physiologic health of the cornea. Alterations in endothelial cell density, coefficient of variation of cell area and percentage of hexagonal cells occur after different surgical methods, in disease conditions, and in normal aging process. Trauma to the endothelium can cause decrease in corneal endothelial cell density, a proportionate increase in mean cell size and corneal thickness and damage to normal hexagonal cell pattern[2]. Endothelial changes are considered important parameters of estimating surgical trauma for determining safety of different surgical methods[3].

Results of phacoemulsification and MSICS are claimed to be equally good in terms of visual outcome but limited number of studies exist regarding the comparison of endothelial cell changes between these two surgical techniques[4]. No such study has been reported in Khyber Pakhtunkhwa, therefore this study is designed to evaluate the corneal endothelial changes in these two common and popular types of cataract surgeries by using the specular microscopy. The results will help us to opt for a more endothelial cell friendly surgical procedure in our patients in routine.

MATERIAL AND METHODS

This randomized controlled trial was conducted in department of ophthalmology, Hayatabad Medical Complex, Peshawar, Pakistan from July 2015 to December 2015 (for the duration of six months). Ethical approval of the study was obtained from the ethical and research committee of the KIOMS. There were total 160 patients, 80 in each group.

Patients from OPD meeting the inclusion criteria were included in study, after taking written informed consent. Inclusion criteria for this study was: patients having age 40 years and above, both male and female patients diagnosed by a consultant after thorough history taking and slit lampexamination,having age related cataracts. Eyes having clear corneas, with ECD at least 1000-1200 cells/mm2 using specular microscope was only be included. Exclusion criteria was:Eyes with traumatic or complicated cataracts, pseudoexfoliation, subluxation of lens or intraocular inflammation like uveitis etc., diagnosed after history and clinical examination. Eyes with uncontrolled glaucoma (IOP>21 with medication), using the Goldmann's tonometer. Eyes which develop hyphema, iris prolapse, vitreous loss intra operatively or with past history of intraocular surgery.

Corneal endothelial integrity was evaluated preoperatively, by measuring the central corneal ECD by a CSO non-contact specular microscope (SP-1, Florence-Italy). The patients after selection were randomly assigned into two groups using lottery method. Each group having equal number of patients (79 eyes). Group 1 patients under went phacoemulsification, whereas MSICS was performed in patients included in group 2.Two consultant surgeons with at least five years post fellow ship experience in the respective surgical technique was selected. Both the surgeons followed a standard surgical protocol for each technique.

Postoperatively, the specular microscopy was performed to measure central corneal ECD at 1st postoperative day and after 2nd and 6th weeks of surgery. But in this article we discussed only the final 6 weeks post-operative central corneal ECD results. Specular microscopy was performed by operator in OPD, who was blinded regarding type of surgery. The procedure for specular microscopy was as follows: three images from central cornea were taken of at least 50 contiguous cells and were manually marked with a mouse by the examiner for analysis by a built- in software program. The computer automatically evaluated, calculated and displayed corneal mean endothelial cell density (cells/mm2). The mean of central corneal ECD from three images of central cornea was calculated and noted. The final outcome readings were measured and data was entered in Performa.

Data was analyzed in SPSS 10. Mean and standard deviation were calculated for quantitative variables like age and endothelial cell density. Frequency and percentages were computed for qualitative variables like gender. T test was performed to compare the postoperative endothelial cell density with the preoperative levels. P value ≤ 0.05 was considered as statistically significant. Results were presented in the form of tables.

RESULTS

This study was conductedatKhyber Institute of Ophthalmic and Medical Sciences (KIOMS), Hayatabad Medical Complex (HMC), Peshawar in which a total

of 160 patients were observed (80 in each group) to compare the changes in central corneal endothelial integrity in eyes undergoing phacoemulsification and manual small incision cataract surgery before and after cataract surgery and between the two surgical procedures. The results were analyzed as; Age distribution among two groups was analyzed as shown in Table 1. There were 42 (53%(males, 38 (47 %) Females in Phacoemulsification Group while 44 (55%) males and 36 (45%) Females in MSICS group.

Table 1: Age distribution among two group (n=160)

Age in years	Phacoemulsification	MSICS	Total
40-50 years	13(16%)	11(14%)	24
51-60 years	33(41%)	34(42%)	67
61-70 years	34(43%)	35(44%)	69
Total	80	80	160
	Mean=61 years *SD ± 1.27	Mean=61 years SD ± 1.31	

*SD: Standard Deviation; Chi square test was applied in which P value was 0.00

Table 2: Central corneal endothelial cell density distribution among phacoemulsification versus MSICS (pre-operative finding) (n=160)

Endothelial Cell Density ECD (cell/mm2)	Phacoemulsification	MSICS	Total
2200-2400	4(5%)	3(4%)	7
2500-2700	8(11%)	8(10%)	16
2800-3000	66(82%)	67(84%)	133
3000-3300	2(2%)	2(2%)	4
Total	80	80	160
	Mean Density = 2852 *SD± 2.13	Mean Density =2950 SD± 2.26	

*SD: Standard Deviation Chi square test was applied in which P value was 0.01

Table 3: Central corneal endothelial cell density distribution among phacoemulsification versus MSICS (6th week post-operative findings) (n=160)

Endothelial Cell Density ECD (cell/mm2)	Phacoemulsification	MSICS	Total
2200-2400	60(75%)	59(74%)	119
2500-2700	20(25%)	21(26%)	41
2800-3000	00(0%)	00(0%)	00
3000-3300	00(0%)	00(0%)	00
Total	80	80	160
	Mean Density = 2348 SD± 2.88	Mean Density = 2408 SD± 2.73	

*SD: Standard Deviation; Chi square test was applied in which P value was 0.02

Table 4: Mean endothelial cell loss (n=160)

Duration		Phacoemulsification	MSICS	P value
Pre-Operative	*ECD (cell/mm2)	2852	2950	
1 post-Operative day	ECD (cell/mm2)	2553	2532	0.03
	Mean Cell Loss	299(10.5%)	418(14.17%)	
2 Week	ECD (cell/mm2)	2505	2476	0.02
	Mean Cell Loss	347(12.2%)	474(16.1%)	
6 Week	ECD (cell/mm2)	2348	2408	0.01
	Mean Cell Loss	504(17.7%)	542(18.4%)	

*ECD: Mean Endothelial Cell Density

Frequency of endothelial cell density pre-operatively was analyzed among two groups. In phacoemulsification group mean endothelial cell density was 2852 cells/mm^2 with standard deviation ± 2.13. Whereas in MSICS group mean endothelial cell density was 2950 cells/mm2 with standard deviation ± 2.26 as shown in Table 2.

Frequency of endothelial cell density postoperatively after 6 weeks was analyzed among two groups. In phacoemulsification group mean endothelial cell density was 2348 cells/mm^2 with standard deviation ± 2.88. Where as in MSICS mean endothelial cell density was 2408 cells/mm2 with standard deviation ± 2.73 as shown in Table 3. Frequency of endothelial cell loss was analyzed among two groups after 6 weeks postoperatively 504 cells/mm2 (17.2%) endothelial cell loss was recorded in phacoemulsification group while 542 cells/mm2 (18.4%) endothelial cell loss was recorded in MSICS group as shown in Table 4.

DISCUSSION

Phacoemulsification is considered safe for the corneal endothelium[3,8,9]. Many studies show corneal endothelial cell loss in MSICS comparable to phacoemulsification. MSICS is considered alternative to phacoemulsification in areas wheresurgeons expert in phacoemulsification and phacoemulsification equipment are not available.

A study comparing phacoemulsification and ECCE found 10% reduction in endothelial cell counts postoperatively in both of these groups 3. Endothelial cell loss was calculated and compared in a study, after conventional ECCE, manual SICS, and phacoemulsification: the endothelial cell counts decreased by 4.72%, 4.21%, and 5.41%, respectively, with no significant differences between the 3 groups post operatively[8]. In another study endothelial cell loss was evaluated after phacoemulsification and ECCE with different capsulotomy methods, 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 V capsulotomy was done[9]. In one other study, the mean endothelial cell loss 6 weeks postoperatively was 15.5% in the phacoemulsification group and 15.3% in the MSICS group[4].

The higher cell loss in our study as compared to other studies is probably due to various factors like different inclusion and exclusion criteria, different method of nucleus delivery while doing MSICS, different types of IOL used, different types of irrigating solutions and different types of ophthalmic visco-surgical devices (OVD) used[10].

In our study patients having all the grades of cataract density (Grade I to Grade V) were included. According to Bourne et al increased brunescence of cataracts was related, to considerably more endothelial cell loss; a hard cataract doubled the risk of severe cornel endothelial cell loss[3].

The endothelial cell loss was less in studies by Sasikumar et al[11] and George et al[8]. This may be due the fact that only immature soft cataracts with grade I-II nuclear sclerosis were included by Sasikumar et al[11] and similarly immature cataracts with nuclear sclerosis grade 3 or less were included by George et al[8]. But when only hard mature cataracts were included in the study by Valle DD[12], the endothelial cell loss was quite high post operatively with cell loss of 28.5% and 34.77% in ECCE and phacoemulsification respectively at 6 months[12]. According to Bourne et al the hard cataract was an important factor in endothelial cell loss in both ECCE and phacoemulsification groups. Patients with a hard cataract had a considerably higher cell loss (17.6%) compared with 12.7% in those with reduced brunescence[3].

A prospective study from United States estimating the long-term (5 year) safety of phakic IOLs[13] showed that the percentage of endothelial cell loss reduced with the passage of time. This approves with results in shorter studies,[13,14] which report a greater rate of endothelial cell loss than longer studies but a decrease with time. Endothelial cell loss is more likely linked to corneal endothelial cell remodeling after surgical trauma than to continuing age-related cell loss. The increase in cells with the passage of time after surgery may be because of endothelial cell renewal by corneal stem cells.[15] A study comparing the outcomes of different phacoemulsification methods on corneal endothelial cells in Denmark 16 showed similar 3-month and 1-year results.

Another limitation of our study is that only 1 technique of phacoemulsification and 1 technique of MSICS were compared; other surgical methods may give changed results. Also, sodium hyaluronate 1.4% (Healon GV) was not used. A higher retention OVD may have caused less endothelial cell loss.

The main reasons to use OVDs in cataract surgery are to reduce endothelial cell loss, to make the anterior chamber deeper, it protect against mechanical surgical trauma, it absorbs phaco ultrasound energy, and make the IOL coating[17]. A study conducted in Italy[17] compared different OVDs including HPMC, Healon (sodium hyaluronate 1.0%), Healon GV, and sodium hyaluronate 3.0%–chondroitin sulfate 4.0% (Viscoat) in phacoemulsification and stated that there is no

significant difference in the postoperative mean endothelial cell loss among the 4 OVD groups. Belda et al[18] recommended that OVD's with greater concentrations of sodium hyaluronate have more protective effect on endothelium. Although a newer OVD with higher retention may have resulted in less endothelial cell loss in our study, the loss would have been the same for either technique group.

In addition, a basic Universal 2 machine (Alcon) was used rather than a newer high-end model for phacoemulsification in our study. In latest models of phacoemulsification machines which are used for MICS (micro incision cataract surgery) technique, the phaco tip uses micro pulse mode. With this phaco delivery system, "cool phaco" is done. Which allows a bimanual phacoemulsification technique with sleeveless phaco aspiration. Increasing the effectiveness of phacoemulsification decreases the total ultrasound power delivered to the anterior segment, also lessen the total phacoemulsification time, which causes less surgical tissue injury and less corneal edema. Kim et al[19] comparedmicro incision versus small incision coaxial cataract surgery by using different power modes for hard nuclear cataractphacoemulsification, the intraoperative energy use and ocular damage was less with the pulse and burst modes than with the continuous mode.

In our study patients having diabetes and short axial length of eye were not excluded. According to Mathew et al[20] and Yamazoe et al[21] shorter axial length and diabetes mellitus were risk factors for greater loss in ECD (endothelial cell density) and bullous keratopathy. In diabetic patients corneal endothelium was found to be under more metabolic stress and less functional reserve while in eyes having shorter axial length the anterior chamber is shallow and the phaco tip and lens fragments are closer to the corneal endothelium during phacoemulsification leading to increased corneal endothelial cell loss.

CONCLUSION

This study concludes that mean corneal endothelial cell loss was slightly less in phacoemulsification as compared to MSICS.

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CONFLICT OF INTEREST: Authors declare no conflict of interest

GRANT SUPPORT AND FINANCIAL DISCLOSURE NIL

AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:

Sultan M: Contribution to the concept design acquisition of data final approval.

Hamza SA: Drafting of manuscript

Saeed N: Bibliography and proof reading surgeon for phacoemulsification

Khan NM: Statistics.

Jan S: Surgeon for MSICS

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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