ORIGINAL ARTICLE

Effect of Phacoemulsification Power on Corneal Endothelial Cell Count and Corneal Thickness in Age Related Cataract Surgery

MUHAMMAD SHOAIB KHAN[1], MUHAMMAD SHARJEEL[2], MUHAMMAD TAHIR GHAFFAR[3], MOHAMMAD HASAN BOKHARI[4], FAISAL ANWAR[5], MUHAMMAD IMRAN NAZIR[6]
[1,3-5]Department of Ophthalmology Eye Unit 3 Mayo Hospital, Lahore.
[2]Senior Registrar Gomal Medical College, Dera Ismail Khan
[6]Associate Professor Medicine BAMC, Multan
Correspondence to: Dr. Muhammad Shoaib Khan, Email: dr.sohaibkhan527@gmail.com

ABSTRACT

Objective: To determine the effect of phacoemulsification power on corneal endothelial cell count and corneal thickness in age related cataract.

Design: It was a quasi-experimental study.

Study Settings: The study was conducted at Department of Ophthalmology Unit III, Institute of Ophthalmology Mayo Hospital/KEMU Lahore from 18/04/2018 to 17/10/2018.

Material and Methods: This study involved 140 patients of both genders aged between 50-60 years undergoing age related cataract surgery. A written informed consent was obtained from every patient. Per-operative phacoemulsification power and time were recorded. Post-operative endothelial cell count and corneal thickness was taken on 1st, 7th and 14th postoperative day. Three readings were taken and mean value was considered.

Results: There was slight female predominance (1:1.2) with a mean age of 55.21±3.0 years. Baseline corneal thickness and endothelial cell count's mean±SD was 548±7.4 µm and 2136.5±104.6 cells/mm^2 respectively. At week 14, the mean corneal thickness was 548.7±7.4 µm at baseline was 572.02±15.25 µm (4.2±2.2% of the baseline) but was still significantly higher than at the baseline (p=0.001). The mean endothelial cell count was in Nuc Cat grade 1 where high power was used was 2376.6±104.6 cells/mm^2 at baseline and decreased to 2173.5±110.35 cells/mm^2 (8.5±2.79% of the baseline) at 14 weeks. Compared to the baseline, this decrease in endothelial cell count was significant (p=0.001). Similar, results were seen in other grades of cataract and with low power as well. When high power were subjected to different grades of cataract, high time showed more cell loss as compared to low time with same power (p=0.02).

Conclusion: A higher power-longer time, low power-longer time showed increased endothelial cell loss and high power-longer time, lower power-longer time predicted increased corneal thickness. So, phacoemulsification power and time played a vital role in damaging endothelial cell with secondary increase in corneal thickness.

Keywords: Age Related Cataract Surgery, Endothelial Cell Loss, Increased Corneal Thickness, Phacoemulsification Power, Phacoemulsification Time

INTRODUCTION

Every normal human eye has a crystalline lens, which may opacify with increasing age. The opacification of lens with increasing age is called age related cataract, which results in gradual decrease of visual acuity. Phacoemulsification is the latest and preferred treatment for age related cataract surgery[1]. It is superior to the conventional cataract surgery procedures in terms of very small incision, minimal postoperative astigmatism, suture-less, early healing, time saving and anterior chamber is maintained during surgery[2]. But during phacoemulsification there is intense heat generation which may result into corneal endothelial cell damage leading to permanent endothelial cell loss[3,4].

Histologically cornea consist of 5 layers and structural integrity of all the 5 layers is necessary for the optimum functioning of the cornea, but the role of endothelium is critical in maintaining corneal clarity[5]. Endothelium is composed of specialized flattened, mitochondria rich cell which form the innermost layer of human cornea. It keeps the cornea in state of relative dehydration by the activity of the Na+/K+ ATPase and carbonic anhydrase due to which corneal transparency is maintained. Corneal endothelial cells are non-regenerating cells and normal adult human cornea has central endothelial cell count up to 2500 to 3000/mm[5-7]. For the proper functioning of the human cornea the endothelial cell count should not be less than 1000/mm. If there is extensive endothelial cell loss during surgery then corneal edema may occur leading to decreased visual acuity and corneal decompensation[7,8]. Corneal endothelial cell count also decreases with age.

Normal thickness of adult human cornea ranges from 0.5mm in the center to 1.00 mm in the periphery[5,9]. Corneal thickness depends upon the water content of cornea and normal functioning of endothelial cells[6]. Corneal thickness changes if there is significant loss of endothelial cell. Corneal thickness can be measured with the help of pachymeter [9]. Specular microscopy is a non-invasive, non-contact and time effective photographic technique that allows to visualize and analyze the size, shape and count of the corneal endothelial cells[10,11].

Aim of this study was to identify the best usage of phacoemulsification power so that there would be minimum corneal endothelial cell loss and minimal change in the corneal thickness in age related cataract surgery for encouraging other ophthalmologists to adequately use the Phacoemulsification power with minimum complications and better visual outcome.

MATERIAL AND METHODS

It was a quasi experimental study conducted at Department of Ophthalmology Unit III, Institute of Ophthalmology, Mayo Hospital/KEMU, Lahore over 6 months from18/04/2018 to

15/10/2018. Patients of both the genders with ages in the range of 50-60 years suffering from age related cataract detectable by slit lamp examination were included in the study while patients having traumatic cataract on slit lamp examination, glaucoma on fundus examination and corneal dystrophies, corneal degeneration and corneal opacity on slit lamp examination, having history of any intraocular surgery, intraocular inflammation e.g. uveitis on clinical examination and slit lamp examination, with any pre-operative complications e.g. posterior capsular rent, any post-operative complication e.g. endophthalmitis, corneal edema on slit lamp examination, with nystagmus, head nodding, neurological problems and who were unable to sit on neurological and slit lamp examinations or patients with endothelial cell count less than 1500/mm^2 on specular microscopy were excluded from the study.

All the patients had a preoperative assessment including slit lamp examination, indirect bio microscopy, applanation tonometry, specular microscopy and biometry. Preoperative endothelial cell count and corneal thickness were measured by automated specular microscopy and pachymeter respectively. Three readings were taken and mean value was considered for final analysis. All surgeries and pachymetry measurements were done by single consultant under topical anesthesia. Same apparatus was used for all patients i.e PHACO tip size -2.5mm, IOL PMMA-5.5mm, Phacoemulsifier-storz protégé, fluid-ringer lactate, viscoelastic-visilon, bottle height-85cm, Temperature -22c^0. Intra-cameral carbachol / adrenalin was not used.

All the collected data was entered and analyzed through SPSS version 20. Spearman correlation coefficient r has been determined to describe relationship between mean phacoemulsification power and mean endothelial cell count and mean corneal thickness taking p-value ≤0.05 as significant.

RESULTS

Majority of the patients who had age related cataract had Nuc Cat grade 4 (n=40, 29%). Posterior sub-capsular cataract comprised only 13% of the total cases (n=18), which was similar with grade1 (n=20, 14%). Grade 2 and 3 had nearly same number of patients (32 and 30 respectively). Mean±SD baseline endothelial cell count was 2136.5±104.6. The median cell count of the endothelium before phacoemulsification was 2078.2 and the count over different patients ranged from 1998 to 2345. Before phaco, mean ±SD corneal thickness was 548.8±7.4 µm. Median thickness over 140 patients was 551.0 µm, while the thickness ranged from 523.0 to 572.0 µm. For corneal thickness (5 categories of cataracts).

Table 1: Corneal thickness in different post-operative periods at different stages of cataract and effective Phaco time using variable powers

Grade of Cataract	Power (High=60%-100% Low=30%-60%)	Effective phaco time (in seconds)	Mean Corneal Thickness (µm)			*P values		
			Day	Values	Difference with baseline n(%)	P1	P2	P3
Nuc Cat Grade 1 (n=20)	High	10	Baseline	548.7	0	0.21	1st POD 0.34	0.001
			1st POD	593.0	44.3 (8.0)			
			7th POD	585.0	36.3 (6.6)			
			14th POW	572.0	23.3 (4.2)			
	Low	14	Baseline	547.8	0			0.001
			1st POD	583.0	35.2 (6.4)			
			7th POD	571.5	23.7 (4.1)			
			14th POW	555.1	7.3 (1.3)			
Nuc Cat Grade 2 (n=32)	High	14	Baseline	549.7	0	0.34	7th POD 0.45	0.001
			1st POD	594.0	44.3 (8.0)			
			7th POD	586.0	36.3 (6.6)			
			14th POW	573.0	23.3 (6.1)			
	Low	18	Baseline	548.8	0			0.001
			1st POD	584.0	35.2 (5.4)			
			7th POD	570.5	21.7 (3.9)			
			14th POW	557.1	8.3 (1.5)			
Nuc Cat Grade 3 (30)	High	17	Baseline	549.7	0	0.78		0.001
			1st POD	597.0	47.3 (8.6)			
			7th POD	589.0	39.3 (7.1)			
			14th POW	575.0	25.3 (4.6)			
	Low	30	Baseline	549.8	0			0.001
			1st POD	582.0	32.2 (5.8)			
			7th POD	571.5	21.7 (3.9)			
			14th POW	558.1	8.3 (1.5)			
Nuc Cat Grade 4 (n=40)	High	24	Baseline	543.7	0	0.98	14th POW 0.76	0.001
			1st POD	591.0	47.3 (8.6)			
			7th POD	588.0	44.3 (7.4)			
			14th POW	575.8	32.1 (5.9)			
	Low	18	Baseline	542.7	0			0.001
			1st POD	586.5	43.8 (8.1)			
			7th POD	572.4	29.7 (7.3)			
			14th POW	551.0	8.3 (1.5)			
Posterior Sub-capsular Cataract (n=18)	High	10	Baseline	548.7	0	0.09		0.001
			1st POD	578.5	29.8 (5.4)			
			7th POD	572.0	23.3 (4.2)			
			14th POW	567.8	19.1 (3.4)			
	Low	14	Baseline	541.1	0			0.001
			1st POD	581.5	40.4 (7.4)			
			7th POD	571.2	30.1 (5.5)			
			14th POW	547.5	6.4 (1.1)			

POD-Postoperative Day
POW-Postoperative Month
P_1 value (thickness versus power used, independent sample t test)
P_2 Value (times require for emulsification versus grade of Cataract, independent sample t test)
P_3 Value (thickness difference at different PODs, paired t test

Table 2: Predictors of corneal thickness

Post Op. days	Measures	High power, longer time	High power, shorter time	Low power, longer time	Low power, shorter time
1st	R	0.95	0.56	0.93	0.81
	r2	0.90	0.31	0.86	0.66
	P value	0.001	0.09	0.001	0.93
7th	R	0.87	0.76	0.93	0.63
	r2	0.75	0.58	0.86	0.40
	P value	0.02	0.08	0.001	0.06
98th (14th week)	R	0.79	0.56	0.93	0.53
	r2	0.62	0.31	0.86	0.28
	P value	0.05	0.23	0.001	0.71

Table 3: Predictors of endothelial cell loss

Post Op. days	Measures	High power, longer time	High power, shorter time	Low power, longer time	Low power, shorter time
1st	R	0.76	0.87	0.86	0.65
	r2	0.57	0.76	0.74	0.42
	P value	0.01	0.09	0.001	0.08
7th	R	0.84	0.84	0.85	0.73
	r2	0.70	0.71	0.73	0.53
	P value	0.04	0.85	0.001	0.92
98th (14th week)	R	0.64	0.76	0.87	0.41
	r2	0.40	0.58	0.75	0.17
	P value	0.05	0.77	0.001	0.45

With the increase in grade of cataract, more power was used for emulsification of cataract. However, higher or lower cataract grade there had no difference in corneal thickness in post-operative days. For corneal thickness (2 categories of cataracts) even with higher or lower cataract grade there was no difference in corneal thickness in post-operative days. Regarding endothelial cell loss (5 categories of cataracts) the grade of the cataract had direct relationship with cell loss which was statistically significant by t test (P_3=0.02). Likewise, endothelial cell loss (high power with different effective phaco time) also showed direct relationship between the grade of the cataract and the loss which was statistically significant by t test (P_3=0.02). For endothelial cell loss (2 categories of cataracts) as the grades of cataract increased, there was more cell loss in when both high and low powers used. (p=0.001). Cell count difference was statistically significant with grades of cataracts (p=0.001), that is; more the grade of cataract more is the cell loss.

DISCUSSION

The opacification of lens with increasing age is called age related cataract, which results in gradual decrease of visual acuity. Phacoemulsification is the latest and preferred treatment for age related cataract surgery[1]. But during phacoemulsification there is intense heat generation which may result into corneal endothelial cell damage leading to permanent endothelial cell loss as well as subsequent corneal edema leading to delayed/ in effective recovery following surgery[3,4]. Existing research has suggested an association between the phacoemulsification power on post-operative corneal endothelial cell count and corneal thickness. However, the available evidence was limited and no such local published material could be found.

In present study, the age of the patients ranged from 50 years to 60 years with a mean of 55.21±3.02 years. A similar mean age of 55.02±5.73 years was also observed by Jamil et al. in another local study involving cataract patients at Layton Rehmatulla Benevolent Trust Eye Hospital, Lahore[71]. However, Baradaran-Rafii et al. in 2009 (60.8±6.6 years) in Iran[72], Atas et al. in 2014 (66.11±8.91 years) in Turkey[73] and Soro-Martínez et al. in 2009 (68±5.96 years) in Spain[74] and Bourne et al. in 2004 (71.8±9.4 years) in United Kingdom[75] reported relatively higher mean age at presentation of Age Related Cataract.

There were 79 (56.4%) male and 61 (43.6%) female patients in the study group giving a male to female ratio of 1.29:1. A similar male to female ratio of 1.27:1 was previously reported by Wahab et al. in another local study at Sindh Govt. Lyari General Hospital, Karachi[76]. Somewhat similar male predominance has been reported by Baradaran-Rafii et al. (1.14:1)[11] and Bourne et al. (1.09:1)[12] in Irani and British such patients respectively.

Baseline corneal thickness and endothelial cell count's mean±SD was 548±7.4 µm and 2136.5±104.6 cells/mm2 respectively. The mean corneal thickness was 548.7±7.4 µm at baseline which increased to 593.02±15.2 µm (8.0±2.2% of the baseline) at Day 1. However, it decreased to 585.0±15.2 µm (6.60±2.16% of the baseline) at Day 7 and 572.02±15.25 µm (4.2±2.2% of the baseline) at 14 week but was still significantly higher than at the baseline (p=0.001).). A possible explanation for this gradual decrease after an initial increase in corneal thickness can be the resolution of post-operative corneal edema. Our results are again in line with those of Atas et al. in 2014 who observed mean baseline corneal thickness to be 544.5µm which increased to 587µm at Day 1 and then gradually decreased to 540µm at Day 28 but was still higher than at the base line73.

The mean endothelial cell count was in Nuc Cat Grade 1 where high power was used was 2376.6±104.6 cells/mm2 at baseline which decreased to 2206.1±110.35 cells/mm2 (7.2±2.79% of the baseline) at Day 1due to destructive effect of the power. The cell count further decreased; stating from day 7 to 2190.5±110.35 cells/mm2 (7.8±2.79% of the baseline) and 2173.5±110.35 cells/mm2 (8.5±2.79% of the baseline) at 14 weeks. Compared to the baseline, this decrease in endothelial cell count was significant (p=0.001). Our results are similar to those of Atas et al. in 2014 who observed mean baseline endothelial cell count to be 2327 cells/mm2 which decreased to 2211 cells/mm2 at Day 1 and 2120 cells/mm2 at day 28 following surgery (p=0.01)73. Our result also match to those of Patel et al. in 2014 who observed 10%

percent decrease in endothelial cell count after phacoemulsification12.Similar results were seen in other grades of cataract and with low power as well.

When high power were subjected to different grades of cataract, high time showed more cell loss as compared to low time with same power (p=0.0W) and lower power-longer time (r2 and P: 0.86, 0.001for all Post-operative periods) were predictors of increased endothelial cell loss in all post-operative periods. Also high power-longer time (r2 and P: 0.57, 0.01; 0.70, 0.04; 0.40, 0.05 respectively for 1st POD, 7th POD and 14th POW) and lower power-longer time (r2 and P: >0.70, 0.001 for all post-operative periods) were predictors of increased corneal thickness in all post-operative periods. Our observation is in line with that of Patel et al. who also observed direct correlation between phacoemulsification time and percent decrease in endothelial cell count.[12]

The present study is first of its kind in local population and has found direct correlation between high phacoemulsification power- longer time/ low phacoemulsification power- longer time and increased endothelial cell loss (%)/ increased corneal thickness (%) in age related cataract surgery.

CONCLUSION

A higher phacoemulsification power-higher time and low phacoemulsification power-higher time were predictors of increased endothelial cell loss (%) and increased corneal thickness (%) in age related cataract surgery which advocates that in future, an optimal phacoemulsification power should be selected which should require shorter phacoemulsification time so that the percent decrease in endothelial cell count (cells/mm^2) and percent increase in corneal thickness (µm) following surgery can be minimized.

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