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ISSN: 2617-0817 E-ISSN: 2789-5912

Original Article

Status of Corneal Endothelial Cells after Phacoemulsification Using 2% Hydroxypropyl Methylcellulose Versus 1.6% Sodium Hyaluronate

DOI: dx.doi.org

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Received: 14 Jun 2024
Accepted: 27 Jun 2024
Published: 28 Dec 2024

Published by:
Sher-E-Bangla Medical College, Barishal, Bangladesh

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ABSTRACT

Introduction: *The single layer of hexagonal cells that lined the back of the cornea is corneal endothelium. Corneal endothelial damage is one of the most important complications during phacoemulsification. Endothelial cell is damage is caused by a number of factors, including the size of the incision, the phacoemulsification technique, nuclear grading, quantity of total ultrasonic energy, composition of irrigation fluid and the production of free radicals. Different types of ophthalmic viscosurgical device (OVD) have been used to protect the corneal endothelium and other intraocular structures from ultrasonic vibration, heat, and free radicals created during phacoemulsification.* ***Objectives****: To evaluate and compare the changes of corneal endothelial cell status after phacoemulsification by using 2% hydroxypropyl methylcellulose (HPMC) and 1.6% Sodium hyaluronate (NaHa) as OVD.* ***Methods & Materials:*** *This longitudinal analytic study was carried out in the Department of Ophthalmology, Bangabandhu Sheikh Mujib Medical University, Dhaka. A total of 80 patients who underwent for cataract surgery were included in this study. The patients were purposively divided into two groups equally (40 in each group) to receive 2% HPMC (Group A) or 1.6% NaHa (Group B) as Ophthalmic viscosurgical devices (OVD). The endothelial cell status were measured preoperatively, 7th POD and 1 month after surgery. Data was processed and analysed with the help of computer program SPSS and Microsoft excel. P value of less than 0.05 was considered as statistically significant.* ***Results:*** *Preoperative, 7th POD and after 1 month of surgery endothelial cell density was significantly reduced in both groups, but in intergroup comparison result was not statistically significant. After 1 month, mean endothelial cell loss in group A was 322.39±118.98 and in group B it was 285.98±105.52. After 1 month of surgery, hexagonality of cells reducesd, but inter group comparison result was not significant.* ***Conclusion:*** *Phacoemulsification and posterior chamber intraocular lens implantation is the gold standard treatment. Though endothelial cell count and its status changes after phacoemulsification by using either 2% HPMC or 1.6% NaHa, there is no significant difference between two groups. So 2% HPMC is as effective as 1.6% NaHa in endothelial cell protection during phacoemulsification.*

Keywords: *Phacoemulsification, Corneal endothelilal cell density, Hydroxypropyl Methylcellulose, Sodium Hyaluronate.*

(The Planet 2024; 8(1): 23-27)

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INTRODUCTION

Cataract is Global Burden of Disease. Vision impairment due to cataract has risen over the past 30 years, despite a decrease in the age-standardized prevalence of cataract. With the progressive aging of the world's population, health issues, such as ocular health, have drawn more attention. Cataracts are among the main causes of blindness globally, accounting for nearly half of all cases of blindness in low-income countries and 5% in high-income countries[1]. In 2020, among overall (all ages) 43.3 million blind and 295 million with MSVI, 17.0 million (39.6%) people were blind and 83.5 million (28.3%) had MSVI due to cataract; blind 60% female, MSVI 59% female[2]. The majority of cataracts are age-related nuclear cataracts, which typically cause vision loss in the sixth decade or later[3]. Phacoemulsification and posterior chamber intraocular lens implantation is the gold standard treatment of cataract. There were two generic terms for cataract extraction – intracapsular, which is no longer applicable and extracapsular. Extracapsular extraction involves removing the lens from its capsule, which is retained within the eye and acts

ISSN: 2617-0817 E-ISSN: 2789-5912

as a barrier between the anterior and posterior segments as well as forming the most usual site for replacement lens implantation. In manual extracapsular cataract extraction a relatively large incision needed to remove lens nucleus. Nowadays, phacoemulsification with posterior chamber intraocular lens (PCIOL) implantation surgery is recognized as the gold standard surgical method for managing cataracts. In this technique, cataract extraction and IOL implantation can be done through a small clear corneal incision[4]. This procedure involves inserting an ultrasonic device into the eye with a fluid-flowing system through a very small corneal incision. While the nucleus is being emulsified, the opaque lens components are removed using irrigation and aspiration. A foldable intraocular lens then injected into the capsular bag. And using this technique, it is possible to quickly restore vision following surgery[5]. Corneal endothelial cell injury is the common complication after cataract surgery. During phacoemulsification of nucleus; high energy, free radicals, small lens fragment liberate from nucleus which can damage corneal endothelium. Depending on the degree of surgical damage, an unpredictable decline in endothelial cell density (ECD) was observed after cataract surgery. After surgery the ECD decrease at an average rate of 2.5% per year for atleast 10 years after surgery[6]. These is 4 times the rate in un-operated eyes. Although the precise reason for the accelerated rate of endothelial cell loss is unknown, it is believed that increased subclinical inflammation, exposure to vitreous humour, diminished innervation, and a reduced supply of nutrients from aqueous humour seem to be responsible[7]. To save endothelium and other structure from damage, different types of ophthalmic viscosurgical devices (OVD) have been used by surgeons since the beginning of surgery. Surface tension, pseudoplasticity, elasticity and viscosity are the four general physical characteristics of OVDs. In order to establish and maintain space during surgery and to preserve the corneal endothelium, an ideal OVD must be biocompatible with ocular tissue. OVDs can be classified as cohesive and dispersive depending on physicochemical and rheological characteristics. Dispersive OVDs, such as 2 % Hydroxypropyl Methylcellulose (HPMC), possess lower molecular weights and shorter molecular chains than cohesive OVDs, and thus stay in the anterior chamber longer. For their total elimination, a prolonged aspiration time is needed. The anterior chamber is supported by cohesive OVDs, such as 1.6 % sodium hyaluronate (NaHa), and they are simple to remove because of their high cohesiveness[8]. Surgeons find it difficult to select the ideal OVD because of its many features and functionalities. No single OVD is an obvious choice, hence it should be customized. The goal of this study was to determine how the use of 1.6% NaHa and 2% HPMC as OVDs affects the condition of corneal endothelial cells following phacoemulsification with posterior chamber intraocular lens (PCIOL) implantation surgery.

OBJECTIVES

To evaluate the effects of phacoemulsification on corneal endothelial cell status by using 2% Hydroxypropyl Methylcellulose (HPMC) and 1.6% Sodium hyaluronate (NaHa) as ophthalmic viscosurgical devices.

METHODS & MATERIALS

Study design: This longitudinal analytic study was conducted in department of Ophthalmology, Bangabandhu Sheikh Mujib Medical University (BSMMU), from June, 2021 to August, 2022. Patient planned for routine cataract surgery by phacoemulsification were enrolled for study. Purposive consecutive sampling technique was applied to collect the sample from the study population. Ethical clearance was applied for IRB commiitte of BSMMU. All patients were informed about the nature of the study and informed written consent was taken before enrollment.

Study procedure: Patients were assessed preoperatively by the slit lamp after pupil dilation. The LOCS III grading system of cataracts was used for cataract grading. From this patients with nuclear color grad 2, 3 & 4 were selected. Complete clinical evaluations including a detailed history, physical examinations, relevant ocular examinations, fundus examination, and corneal endothelial cell status were done. All selected patients underwent phacoemulsification by same machine (CENTURION Vision System, Alcon), by a same experienced surgeon and receive same type of IOL (foldable IOL). Patients were chosen purposively to receive either HPMC (Group A) or NaHa (Group B) as OVD. At first pupillary dilatation was achieved by a combination of a topical mixture of 0.8% tropicamide and 5% phenylephrine. The eyeball was sterilized with 5% povidone-iodine and irrigation was done with sterile balanced salt solution (BSS). Same sized clear corneal incision (2.4 mm) was made. 2% HPMC or 1.6% NaHa was injected into the anterior chamber as OVD, and then continuous curvilinear capsulorhexis (CCC) was created with cystotome. Hydrodissection and hydrodelianation were performed with BSS to achieve free rotation of the nucleus. In bag nuclear phacoemulsification was done with stop and chop technique, and the lens and cortex were suctioned by irrigation and aspiration (I/A). Then capsular bag was inflated with OVD and implantation of a foldable intraocular lens (IOL) was done. Viscoelastic substances were completely aspirated by irrigation and aspiration. Finally, the incision was closed by stromal hydration and intracameral ceftazidime was given in every case. All patients had the same surgical technique. All patients were treated post-operatively with moxifloxacin (0.5%) and difluprednate (0.05%) eye drops.

Follow up and data collection: Patients were again examined on 1st post-operative day (POD), 7th POD and after 30 days of operation. But endothelial cell micrograph was obtained by same specular microscope before operation, 7th POD and 30 days after surgery. The demographic information relevant history, examination findings, investigation reports, fundus examination, IOP, corneal endothelial cell status of all the study subjects were recorded in the data collection sheet.

Data Analysis: After completion, the data was presented in the form of tables, figures and graphs as necessary. Statistical analysis of the result was done by using computer-based

ISSN: 2617-0817 E-ISSN: 2789-5912

software SPSS version 22 (SPSS in., chicago, IL, USA). Descriptive statistics: Mean, SD, chi-square test, unpaired-t test, paired-t test. A probability "P" value of 0.05 or less was considered as significant.

RESULT

Table – I: Demographic profile of the respondents (*n*=76)

	Group A (n = 38)	Group B (n = 38)	p-value
Mean age (years)	60.24±6.52	60.26 ±7.7	0.946
Gender			
Male	18 (47.4)	18 (47.4)	1.000
Female	20 (52.6)	20 (52.6)	
Eye involvement			
Left	18 (47.4)	26 (68.4)	0.063
Right	20 (52.6)	12 (31.6)	

Table I showed demographic profile. The mean age was 60.24±6.52 years and 60.26 ±7.7 years in Group A and group B respectively. More than half (52.6%) of population were female in group A and also group B. It was observed 20 (52.6%) patients had right eye involved in group A and 12(31.6%) group B. The differences of demographic profile were not statistically significant between two groups.

Table – II: Evaluation of endothelial cell density following surgery (*n*=76)

Cell density	Group A (n=38)	Group B (n=38)	[a]P-value
	Mean±SD	Mean±SD	
Pre-operative	2858.9±239.24	2855.6±215.17	0.949[ns]
After 7 days	2671.9±266.51	2696±221.98	0.669[ns]
P-value	0.001[s]	0.001[s]	
Percentage of decreased (%)	4.69±10.26	3.67±8.43	0.637[ns]
After 30 days	2536.6±269.06	2569.6±214.04	0.555[ns]
P-value	0.001[s]	0.001[s]	
Percentage of decreased (%)	10.39±12.04	8.65±9.09	0.479[ns]

Table II shows the cell density. In group A it was observed that mean endothelial cell density reduced from 2858.9±239.24 to 2671.9±266.51 and 2536.6±269.06 on after 7 days and after 30 days of operation respectively. Similarly, in group B mean endothelial cell reduced from 2855.6±215.17 to 2696±221.98 and 2569.6±214.04 on after 7 days and after 30 days of operation respectively. This reduction was statistically significant in group A and B but between groups changes was not significant. (Table II).

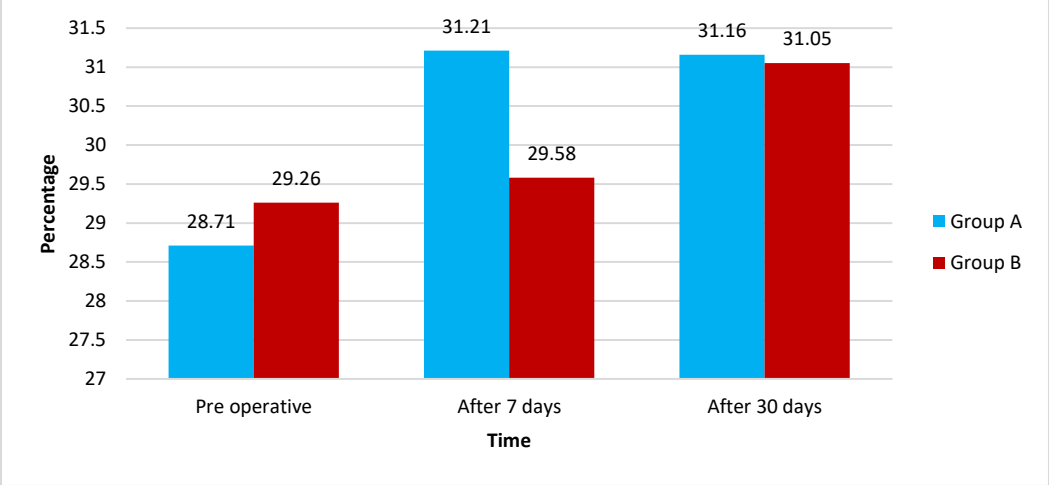

Figure – 1: Distribution of the study population according to coefficient of variation (CV) in cell size (*n*=76)

Figure 1 shows that pre operatively in group A mean coefficient of variation in cell size was 28.71 which became 31.21 after 7 days of operation and 31.16 on 30 days after operation. In group B, mean CV was 29.26 pre operatively which became 29.58 and 31.05 after 7 days and 30 days post operatively respectively (Figure-1).

DISCUSSION

Ophthalmic viscosurgical device (OVD) helps to protect corneal endothelium as well as facilitate different steps during surgery. There are different viscoelastic substance are available in market which have different chemical, physical and rheological properties and they are broadly classified as cohesive and dispersive. In this study we use dispersive (2% HPMC) in group A and Cohesive (1.6% NaHa) in group B to see the comparative safety of these two OVD's.

ISSN: 2617-0817 E-ISSN: 2789-5912

In this study, mean age was 60.24±6.52 years in group A and 60.26±7.7 years in Group B. More than half, 20(52.6%) of population were female in group A and also group B. The differences of age and sex were not statistically significant between two groups. In a similar study, Bamdad et al.[9] reported that mean age was 62.1±12.2 years and 43 were females and 42 were males. Maár et al.[10] and Riaz et al.[11] also discovered female dominance in their research. Kalode and Sune[12] reported that comparing the age distribution of the two study groups, it was found that the mean age in HPMC group was 63.23 ± 6.074 years, whereas in NaHa group, the mean age was 64.11 ± 7.43 years, with no significant difference between the two groups which is comparable to our study.

In this study, it was observed that, in group A mean endothelial cell density reduced from preoperatively 2858.9±239.24 to 2671.9±266.51 and 2536.6±269.06 on after 7 days and after 30 days of operation respectively. Similarly, in group B mean endothelial cell reduced from preoperatively 2855.6±215.17 to 2696±221.98 and 2569.6±214.04 on after 7 days and after 30 days of operation respectively. This reduction was statistically significant in group A and B but intergroup, changes was not significant. After 30 days, total number of cell loss in group A was 322.39±118.98 and group B was 285.98±105.52. This difference was also not statistically significant between two groups.

Findings consistent with result of other study. Riaz et al.[11] concluded that 2% HPMC is superior to 1% NaHa in protecting corneal endothelial cells. In HPMC group mean endothelial cell loss after 6 week was 212.16 ± 12.06 and in NaHa group was 359.67 ± 58.50 and was statistically significant. Ray-Chaudhuri et al.[13] reported mean cell density significant fall of 11.76% for Sodium Hyaluronate and 4.27% for HPMC at 12 weeks postoperatively, the difference between the two being significant (p=0.009), which makes HPMC superior. They conclude that as HPMC is a dispersive OVD, it protect endothelial cells more than cohesive by retained during surgery and makes a coat over endothelial cells during surgery which protect it from damage during surgery. But their result is not comparable with current study.

Storr-Paulsen et al.[14] analyzed the protective effect of cohesive and dispersive OVDs, Celoftal (HPMC 2%), Vitrax (sodium hyaluronate 3%), and Healon (sodium hyaluronate 1%) on the corneal endothelium in phacoemulsification with implantation of a foldable posterior chamber IOL. They showed that each of the three groups saw a substantial reduction in cell count; this is consistent with the current study. Maár et al.[10] conducted a study to evaluate the defensive effect of sodium hyaluronate 1% (Healon) and sodium hyaluronate 3%-chondroitin sulfate 4% (Viscoat) during phacoemulsification procedure. They demonstrated that there were no significant changes between preoperative and postoperative endothelial cell density measurements in either group. In NaHa group, ECD decreased from preoperative 2356.88 ± 92.31 to 2342.08 ± 95.45 and 2337.83 ± 98.15 on 7 days and 1 month following surgery, and in Viscoat group it was preoperatively 2282.65 ± 69.47 to 2282.74 ± 84.67 and 2286.87 ± 91.07 on 7 days and 1 month after surgery respectively. The percentage of cell loss was same in both groups and it was 1.5%. They came to the conclusion that OVDs protect the endothelium during phacoemulsification not by their coating ability but by creating enough room during surgery. This is much lower than our findings.

Moschos et al.[15] analyzed the corneal changes of Viscoat (sodium chondroitin sulfate 4.0%-sodium hyaluronate 3%) and Visthesia (sodium hyaluronate 1.5% and lidocaine hydrochloride 1%) in patients experiencing phacoemulsification. And they found the density decreased by 29 cells/mm^2 (1.2% loss) in the Viscoat group and by 217 cells/mm^2 (9.6% loss) in the Visthesia group 28 days postoperatively and this result was statistically significant. Our study also found similar loss of cell in 1.6% NaHa group.

It was observed that the mean pre-operative coefficient of variation (CV) in cell size was 28.71±4.05 in group A and 29.26±5.07 in group B. after 7 days of operation, the mean CV was 31.21±4.39 in group A and 29.58±3.08 in group B. and after 30 days it was 31.16±4.19 in group A and 31.05±4.74 in group B. The differences of pre-operative, after 7 days and after 30 days of CV were not statistically significant (p>0.05) between two groups.

Previous study observed no difference in the coefficient of variation in cell size across the groups, while comparing Celoftal (HPMC 2%), Vitrax (sodium hyaluronate 3%), and Healon (sodium hyaluronate 1%) preoperatively and 3 months following surgery and comparable with this study[14]. Maár et al.[10] showed when comparing Healon and Viscot, there was no noticeable change in preoperative and postoperative CV between the two OVDs. Rai- Choudhury et al.[13] reported that the coefficient of variation (CV) in cell size in the central cornea was found to be normal by 12 weeks in their both groups.

CONCLUSIONS

After analyzing the results of this study it can be concluded that, after using both HPMC or NaHa, endothelial cell count significantly reduced after phacoemulsification from baseline. But there is no statistically difference in both. So 2% HPMC is as effective as 1.6% Sodium Hyaluronate in endothelial cell protecting during phacoemulsification.

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