MEAN INTRAOCULAR PRESSURE AFTER PHACOEMULSIFICATION USING HYDROXYPROPYL METHYLCELLULOSE AND SODIUM HYALURONATE AS VISCOELASTIC

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ABSTRACT

Background: The goal of advancing surgical phacoemulsification techniques is to improve visual acuity (VA) restoration. Ophthalmic viscosurgical devices (OVDs), such as 1% Sodium Hyaluronate (NaHa) and 2% hydroxypropyl methylcellulose (HPMC) are commonly used to maintain the stability of the anterior chamber and ocular tissues. However, residual OVDs can increase intraocular pressure (IOP), which is a major postoperative problem.

Objective: This research investigated the effects of 1% Sodium Hyaluronate (NaHa) and 2% Hydroxypropyl Methylcellulose (HPMC) on intraocular pressure levels after surgery in phacoemulsification.

Materials and Methods: This quasi-experimental study was conducted at Hayatabad Medical Complex in Peshawar from September 2018 to March 2019. Eighty patients undergoing phacoemulsification and IOL implantation were assigned to two groups in which Group A received 1% NaHa while those in Group B received 2% HPMC. IOP was measured preoperatively and after surgery with the Goldman Applanation Tonometer. Data analysis was done with SPSS version 22.

Results: IOP before surgery was similar in the two groups (p=0.979). Group A which received 1% NaHa suffered a greater increase in IOP with a mean IOP (16 ± 1.28 mmHg) after surgery than Group B (15 ± 1.07 mmHg), (p=0.0001). Age and gender stratification showed that postoperative IOP was greater in the NaHa group.

Conclusion: The research demonstrates that 1% NaHa is associated with a greater postoperative IOP rise compared to 2% HPMC.

Keywords: Phacoemulsification, Intraocular Pressure, Sodium Hyaluronate (NaHa), Hydroxypropyl methylcellulose (HPMC), Ophthalmic Viscosurgical Devices.

INTRODUCTION

Phacoemulsification has proven to be the most efficient method for visual restoration and recovery (1). The use of small 2.7-3.2 mm incisions is typically necessary for this technique, which eliminates the need for sutures. Kelman introduced it in 1967 to treat cataract and it works by emulsifying the cataractous lens (2).

This is an advanced approach with good safety and outcome (3). Intraocular Pressure (IOP) is the pressure the fluid exerts within the eye. The aqueous humor passage through the anterior and posterior chambers is vital for eye shape maintenance and visual function (4). This fluid carries out several vital functions, including transport of neurotransmitters, nutrition, and support of the avascular lens and cornea, along with structural support of the eye (5).

Viscoelastic substances (VES) are also referred to as Ophthalmic Viscosurgical Devices (OVDs). These substances play an essential part during cataract surgery because of their viscosity and stickiness. They not only maintain anterior chamber depth during phacoemulsification but also help protect the ocular tissues and assist in intraocular lens implantation. They serve to substitute for the aqueous humor during the process, which prevents any injury to the eye and guarantees a successful procedure (6).

Viscoelastic Substances, when used in phacoemulsification, protect the corneal

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endothelial cells and help in performing Continuous Curvilinear Capsulorhexis (ccc) by maintaining the depth of the anterior chamber. In addition, with the aid of VES, intraocular tissues are stabilized, and the capsular bag is filled before the IOL is implanted. The general classification for VES is either cohesive or dispersive (7, 8).

Hydroxypropyl methylcellulose (HPMC) at 2% and sodium hyaluronate at 1% are two widely used viscoelastic substances during phacoemulsification, both having different rheological profiles that can interfere with the outcomes of the surgery, such as IOP postoperatively (9). Sodium Hyaluronate (1%) is a cohesive VES with high molecular weight and viscosity, providing stability and sustaining the anterior chamber. However, HPMC (2%), a dispersive VES, retains a lower viscosity and has shorter molecular chains, which makes it quite effective at protecting the endothelium during the surgery (6).The major concern with these products is that any retained product may interfere with the aqueous outflow channels, elevating the intraocular pressure (IOP). A spike in IOP can lead to optic nerve damage, resulting in permanent vision loss (11).

The selection of viscoelastic substances affects IOP postoperatively, which plays a critical part in visual outcome after cataract surgery. Therefore, the selection and thorough removal of these agents may decrease the potential risk for an elevated IOP.

Consequently, the objective of this investigation was to assess the effects of 1% NaHa and 2% HPMC on IOP levels post-phacoemulsification.

MATERIALS AND METHODS

This quasi-experimental study was performed at Ophthalmology Department, Hayatabad Medical Complex (HMC), Peshawar, between September 2018 and March 2019.

The investigation used 2% Hydroxymethyl Cellulose (HPMC) and 1% Sodium Hyaluronate (SH) viscoelastic substances to find out the intraocular pressure (IOP) of patients who underwent phacoemulsification and implantation of an intraocular lens (IOL) within the first 24 hours after the surgery.

Among the 80 patients who were divided into two categories, were selected using consecutive non-probability sampling. The study included normal preoperative IOP (11 mm Hg to 21 mm Hg), age-related cataract causing dimness of vision, and patients aged between 45 to 70 years. The exclusion criteria comprised evidence of past intraocular surgeries, presence of glaucoma, signs of inflammation in the eye during slit lamp examination, and diabetes, which was diagnosed through blood glucose as well as HbA1c levels of an individual. Sample size was estimated using a confidence interval of 95% and 80% power of the test using the WHO sample size calculator.

Upon receiving permission from the hospital's ethical board for carrying out the research investigation, all those patients who would be admitted after giving the informed consent for phacoemulsification with implantation of IOL as per the indication of age-related cataract through OPD to Eye A Ward were evaluated. Prior assessment, each participant was given comprehensive details about the trial, and their informed written permission was obtained. Visual acuity was recorded according to the Snellen chart. All of the above patients had a thorough examination using a slit lamp to detect any symptoms of intraocular inflammatory activity in the anterior chamber or evidence of previous intraocular surgery, like scars or suture marks. Gonioscopy was done for glaucoma to exclude angle closure. Their pupils were dilated with tropicamide eye drops, and detailed fundus examination was done.

The eligible patients were divided into two groups. Group A received 1% sodium hyaluronate, whereas Group B received 2% hydroxymethyl cellulose as the viscoelastic agent throughout the procedure.

A comprehensive proforma was planned for the patient demographic details, along with pre-operative IOP readings. All the surgical procedures were done by a single ophthalmologist to lessen the variation in results. The standard procedure of phacoemulsification with IOL insertion was undertaken, and the anterior chamber was maintained by use of viscoelastic agents to protect the corneal endothelium. IOP was measured one day after surgery using a Goldman Applanation Tonometer, and no pressure-lowering drugs were administered during the study period.

Data analysis was done using version 22 of SPSS. Frequency and percentages were calculated for gender. Mean and SD were calculated for age and intraocular pressure of both groups preoperatively and on the first postoperative day. A Student's t-test was used to relate the mean IOP of both groups. Mean IOP was stratified among age and gender. This post stratification analysis was done through an independent t-test. *p*-value of < 0.05 was taken as significant.

RESULTS

The investigation involved 80 participants that were divided into two groups: Group A (n=40) was given 1% Sodium Hyaluronate and Group B (n=40) was given 2% Hydroxymethyl Cellulose. **Table 1** presented the demographics of the participants included. The age range distribution was parallel among both groups. The gender distribution in the groups showed that Group A comprised 35% men and 65% females, while Group B comprised 57% males and 42% females.

Table 1: Demographics Distribution of Participants

Demographics	Group A (n=40)	Group B (n=40)
Age Group		
45-55 Years	20 (50%)	20 (50%)
56-70 Years	20 (50%)	20 (50%)
Gender		
Male	14 (35%)	23 (57%)
Female	26 (65%)	17 (42%)

In **Table 2,** the mean intraocular pressure (IOP) comparison pre- and postoperatively. The mean variance in IOP before surgery among both groups was comparable, as shown by the p-value (p = 0.979). However, IOP after the procedure for Group A (16 ± 1.21) was significantly changed as compared to Group B (15 ± 1.07) with a p-value of 0.0001.

Table 2: Evaluation of Mean IOP between Group A (1% Sodium Hyaluronate) and Group B (2% Hydroxymethyl Cellulose) (n=80)

Mean IOP	Group A (n=40)	Group B (n=40)	P-Value
Pre IOP	12 ± 0.09	12 ± 0.21	0.979
Post IOP	16 ± 1.28	15 ± 1.07	0.0001*

Group A (1% Sodium Hyaluronate) and Group B (2% Hydroxymethyl Cellulose), before and after surgery
Student's t-test was applied
**p-value of less than 0.05 was considered statistically significant*

Table 3 showed the stratification of the mean IOP levels through age and gender. The patients aged 45-55 years, and those in the 56-70 age range showed no change in the IOP, while IOP after surgery in Group A (16 ± 0.42) was significantly greater than in Group B (14 ± 0.74) (p-value = 0.0001), and IOP in Group A (17 ± 1.45) was also significantly greater than in Group B (15 ± 1.12), with a p-value of 0.0001.

IOP before was similar for males (p = 0.49) and females (p = 0.790). Postoperative IOP was significantly higher in male (16 ± 1.62 vs. 14 ± 1.03, p = 0.0001) and female (16 ± 1.04 vs. 15 ± 0.98, p = 0.0002) patients in Group A than in Group B.

Table 3: Mean IOP stratification with Respect to Age and Gender (n=80)

Age/Gender	Mean IOP	Group A (n=40)	Group B (n=40)	P-Value
45-55 Years	Pre Op IOP	12 ± 0.21	12 ± 0.17	0.89
	Post Op IOP	16 ± 0.42	14 ± 0.74	0.0001*
56-70 Years	Pre Op IOP	12 ± 0.23	12 ± 0.22	0.97
	Post Op IOP	17 ± 1.45	15 ± 1.12	0.0001*
Male	Pre Op IOP	12 ± 0.65	12 ± 0.21	0.49
	Post Op IOP	16 ± 1.62	14 ± 1.03	0.0001*
Female	Pre Op IOP	12 ± 0.05	12 ± 0.21	0.790
	Post Op IOP	16 ± 1.04	15 ± 0.98	0.0002*

Group A (1% Sodium Hyaluronate) and Group B (2% Hydroxymethyl Cellulose), before and after surgery
Student's t-test for independent samples was applied
The p-value for the preoperative IOP comparisons in both age and gender groups was not significant (p>0.05).

DISCUSSION

Ophthalmic Viscosurgical devices (OVDs), referred to as viscoelastics, enable cataract surgery by keeping the anterior chamber depth and general structure intact. This gives the surgeon enough room and a viscous layer to protect the sensitive corneal endothelium (12). The authors discovered that the intraocular lens, injector, cataractous lens debris, and surgical equipment were the primary causes of corneal endothelial injury during the insertion process (12). According to Kalode et al., one of the most common post-operative complications following phacoemulsification surgery is elevated intraocular pressure (13). The main contributor to the initial post-operative increase in intraocular pressure (IOP) was trabecular meshwork obstruction caused by residual OVD within the eye (14). The study by Bardoloi et al. also found that the main causes of the postoperative rise in intraocular pressure was residual viscoelastic and susceptibilities such as trabecular damage or undiagnosed glaucoma (15). The increase in intraocular pressure (IOP) can be substantial, especially if the viscoelastic material has not been completely cleared from the eye. This syndrome, formerly known as "Healon block glaucoma," usually develops within the first 6-24 hours following surgery and disappears within 72 hours (9) Though there have been many surgeries to completely remove OVDs, mainly the posterior part behind the intraocular lens (IOL), so far none of the surgeries have been able to prevent postoperative increases in intraocular pressure (16).

Sodium hyaluronate and hydroxypropyl methylcellulose are frequently used ophthalmic viscosurgical substances and have dissimilar effects on intraocular pressure (17). The increased viscosity of NaHa could obstruct the outflow of aqueous humor in case OVD is not fully removed, and this incomplete removal then leads to the increase in the intraocular pressure (18). HPMC is a dispersive OVD with lower viscosity and smaller molecular size, facilitating easier removal from the anterior chamber. This characteristic reduces the likelihood of trabecular meshwork obstruction and subsequent IOP elevation (19). In the present study, 80 participants were divided into two groups: Group A (1% Sodium Hyaluronate) and Group B (2% Hydroxymethyl Cellulose), with no significant preoperative IOP difference (p = 0.979). Postoperatively, Group A showed a significantly higher IOP (16 ± 1.28) compared to Group B (15 ± 1.07, p = 0.0001).

A research investigated corneal endothelial changes and intraocular pressure (IOP) changes following uncomplicated cataract surgeries performed by the same surgeon (MGA), comparing 3% and 1.8% sodium hyaluronate (NaHa) used during capsulorhexis and phacoemulsification (20). In a study of 20 patients, one eye received 2% hydroxypropyl methylcellulose (HPMC) and the other 1% Hyaluronic acid. The HPMC group required significantly more time and effort for OVD removal and total surgery (P=0.001), with four eyes experiencing IOP spikes that required treatment. Post-surgery, IOP was in sync to 15–20 mmHg in both eyes (21).

A comparative study on cataract patients revealed that postoperative intraocular pressure (IOP) increased significantly in both sodium hyaluronate (Na-HA) and hydroxypropyl methylcellulose (HPMC) groups, with a greater rise in the Na-HA group (p=0.003). Elevated IOP above 21 mmHg occurred in 32% of Na-HA cases versus 16% in HPMC cases on the evening of surgery, with maximum IOP levels of 44 mmHg and 33 mmHg, respectively. By the next morning, IOP levels had nearly returned to normal in both groups (22). Comparative research was conducted in the Department of Ophthalmology, Khyber Teaching Hospital, Peshawar, examining intraocular pressure (IOP) changes after cataract surgery using 2% Hydroxymethyl Cellulose (Group 1) and 1% Sodium Hyaluronate (Group 2) as viscoelastic substances. Results showed that Group 1 experienced a significantly greater rise in IOP at one week post-surgery compared to Group 2 (23).

CONCLUSION

The research demonstrates that 1% NaHa is associated with a greater postoperative IOP rise compared to 2% HPMC. These findings underscore the necessity for ophthalmic surgeons to be proficient in techniques that ensure the optimal application and complete removal of viscoelastic substances (VES) to mitigate postoperative IOP complications.

DECLARATIONS

Authors' contributions

Dr. Bakht Danyal Khan: substantial contributions to design, analysis and interpretation of data, approval of work, drafting text.

Dr. Aleena Khan: Interpretation of data and critical appraisal of the manuscript with revisions.

Dr. Sofia Iqbal: substantial contributions to design, analysis and interpretation of data. critical appraisal of the manuscript.

Dr. Abdul Basit: contributions to design, and drafting of the manuscript.

Shehryar Mohibullah: Contributions to design and data interpretation, critical appraisal of the manuscript.

Conflicts of Interest: None declared by any authors

Funding: No external funding

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