Comparison of Anatomical and Functional Outcomes of Viscoimplantation and Hydroimplantation Techniques in Foldable Intraocular Lens Implantation

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Abstract

Aim: The aim of this study was to compare the anatomical and functional results of viscoimplantation and hydroimplantation techniques in monofocal foldable intraocular lens implantation.

Methods: The study included 387 patients older than 50 years who underwent surgery for senile cataract. They were divided into two subgroups as hydroimplantation (group 1) and viscoimplantation (group 2).

Results: The mean implantation time was 397.5±44.3 s in group 1 and 580±105.1 s in group 2. During the follow-up period (12 months), 4 (2.1%) patients in group 1 and 28 (14.6%) patients in group 2 developed posterior capsular opacification. The implantation time was shorter and the rate of posterior capsular opacification was lower in group 1 compared to group 2 ($p<0.001$). Intraocular pressure measurements were 16.5±2.87 mmHg in group 1 and 20.3±2.9 mmHg in group 2 at the first hour after surgery. At the twenty-fourth hour, the mean intraocular pressure was 14.1±1.3 mmHg in group 1 and 17.5±1.8 mmHg in group 2. This difference between the groups was statistically significant ($p=0.011$ and $p<0.001$, respectively).

Conclusions: In the hydroimplantation technique, the changes in anterior segment parameters between the preoperative and postoperative period are very small. It causes less intraocular pressure elevation. Therefore, hydroimplantation is a cost-effective, safe and effective method for monofocal foldable intraocular lens implantation in uncomplicated cataract surgeries

Keywords: *Cataract, Hydroimplantation, Intraocular Lens, Viscoimplantation*

1. Introduction

Small incision cataract surgery is the preferred method of cataract surgery by most surgeons. Ophthalmic viscoelastic materials (OVDs) have numerous advantages during small incision cataract surgery. OVDs protect the corneal endothelium against fluid turbulence, free oxygen radicals released during ultrasonic fragmentation, contact with surgical instruments, air bubbles and lens fragmentation[1,2]. In addition, it facilitates the surgical procedure, reduces the risk of secondary damage to delicate intraocular tissues, and creates and stabilizes the anterior chamber[3]. These positive aspects may vary according to the physical, chemical and rheologic properties of OVDs[4].

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An ideal OVD should be easily injected into the eye, contribute to the formation and maintenance of the anterior chamber, trap air bubbles, not increase intraocular pressure (IOP) and be easily cleaned at the end of the operation[5,6].

An important disadvantage of OVDs is the increase in IOP, especially in the early period after cataract surgery due to the length of stay in the eye. Molecules that cannot be completely cleared after surgery mechanically occlude the trabecular meshwork, preventing the outflow of aqueous humor and causing IOP increases within 24 hours after surgery, which has become a concern especially for glaucoma patients[7-10]. In addition, viscoelastic materials, especially behind the intraocular lens, cause early development of posterior capsular opacification (PCO) and the need for a higher Neodymium-doped Yttrium Aluminum Garnet (Nd:YAG) laser[11].

Therefore, OVDs should be completely removed at the end of the operation to avoid these complications. It is a more rational approach to use OVDs in a limited way to reduce these disadvantages. In this context, some cataract surgeons have preferred the hydroimplantation technique for intraocular lens implantation (without OVDs).

Tak was the first to describe the hydroimplantation technique[12]. In this technique, intraocular lens implantation is performed under continuous balanced salt solution irrigation without OVDs. Many studies have reported the safety of the hydroimplantation technique

in the literature[13-15].The aim of our study was to compare the anatomical and functional results of viscoimplantation and hydroimplantation techniques in foldable intraocular lens implantation.

2. Materials and methods

This retrospective, cross-sectional study included 387 patients older than 50 years who underwent surgery for senile cataract between January 2020 and July 2021 at our clinic. Patients with Marfan syndrome, lens ectopia, homocystinuria, history of trauma, history of previous ophthalmic surgery, pseudoexfoliation, uveitis, glaucoma, corneal haze, corneal astigmatism greater than 1.25 diopters (D) and axial length greater than 25 mm were excluded.

Patients who underwent cataract surgery with phacoemulsification with a 2.8 mm clear corneal incision under topical anesthesia were included in the study. In all patients, 3% sodium hyaluronate was used to form the anterior chamber during cataract surgery. Patients were divided into two subgroups. These were those who used balanced salt solution (hydroimplantation) for monofocal foldable intraocular lens (hydrophobic, acrylic) implantation (following removal of cortical material in the final stage of the operation (group 1) and those who used ophthalmic viscoelastic material (group 2). Both techniques were used by two surgeons (ESG, ÖÖ). After monofocal foldable intraocular lens implantation with ophthalmic viscoelastic material, the remaining viscoelastic material in the eye was attempted to be removed both from the front of the foldable intraocular lens and from the space between the intraocular lens and the posterior capsule using irrigation and aspiration (I/A) probes. No intraoperative posterior capsule rupture was observed in any patient. Both surgeons have experience of more than a thousand cataract surgeries. Moxidexa 5 mg/1 mg sterile ophthalmic solution (5.45 mg moxifloxacin and 1.1 mg dexamethasone sodium phosphate, Abdi Ibrahim, Istanbul, Turkey) was used every 4 hours for two weeks after surgery.

Age, gender and laterality to be operated on were recorded in all patients. Anatomical measurements of all patients were performed with Eyestar 900 (HAAG-STREIT AG, Koeniz, Switzerland) before and one month after surgery. SRK/T and Barrett Universal II formula were used for intraocular lens power calculation. Surgical time was calculated from the time the clear corneal incision was made to the time the corneal incisions were closed and implantation time was calculated from the time the cortical material was completely removed to the time the corneal incisions were closed. Anatomic lens position (ALP), a marker of effective lens position, was defined as the total distance between the corneal epithelium and the anterior surface of the lens.

In the postoperative period, best-corrected visual acuity (logMAR), intraocular pressure measurements with Goldmann applanation tonometry (preoperatively and at the 1st hour, 4th hour and 24th hour after surgery) and complete ophthalmologic examination were performed. Patients were followed up for at least 12 months for intraoperative and postoperative complications. Posterior capsular opacification (PCO) was subjectively evaluated by retro-illumination on slit-lamp examination. When Elschnig's pearls or fibrosis was seen in the posterior capsule, the patient was considered to have developed PCO.

The necessary permissions were obtained from Local Ethics Committee before this study (07/12/2022 - 2022/807). The principles of the Declaration of Helsinki were followed throughout the study. Written informed consent was obtained from all participants.

Statistical analysis was performed using IBM SPSS Statistics 28.0.1.0 (Armonk, NY, USA). Shapiro-Wilk test was used for the conformity of the data to normal distribution. Numerical data were expressed as mean and standard deviation. Student t test was used for comparison in independent groups in two groups, and ANOVA test was used if the number of groups was more than two. Categorical data are shown with number (percentage-%). Chi-square test was used to compare categorical data. Statistical significance was accepted when $p<0.05$.

3. Results

Of the patients included in the study, 195 (50.4%) underwent hydroimplantation (group 1) and 192 (49.6%) underwent viscoimplantation (group 2). Of the operated eyes, 194 (50.1%) were right and 193 (49.9%) were left. Of the patients, 188 (48.6%) were male and 199 (51.4%) were female. The mean age of patients in group 1 was 64.7±5.8 years, while the mean age of patients in group 2 was 63.4±5.1 years. Demographic characteristics were similar between the patient groups ($p>0.05$, for all) (Table 1).

Table 1

Demographic characteristics of the patients

	Group 1	Group 2	p
N	195	192	
Age (year)	64.7±5.8	63.4±5.1	0.227
Right (n,%)	96 (49.2%)	98 (51%)	0.721
Left (n,%)	99 (50.8%)	94 (49%)	
Male (n,%)	92 (47.2%)	96 (50%)	0.579
Female (n,%)	103 (52.8%)	96 (50%)	

Table 2

Patients' preoperative anatomical measurements and calculated IOL power

	Group 1	Group 2	p
N	195	192	
Axial Length (mm)	23.34±1.2	23.24±1.3	0.626
Anterior Chamber Depth (mm)	3.19±0.46	3.22±0.6	0.693
Central Corneal Thickness (µm)	537.8±36.2	529.7±43.1	0.157
White to white distance (mm)	11.92 ± 0.72	11.91 ± 0.56	0.842
SRK/T (D)	21.5±1.8	21.4±1.8	0.737
Barrett Universal II (D)	21.5 ± 1.8	21.3 ± 1.9	0.811

Table 3

Patients' preoperative anatomical measurements and calculated IOL power

	Group 1	Group 2	p
N	195	192	
Postoperative Anterior Chamber Depth (mm)	3.38±0.7	3.54±0.72	0.021
Postoperative Central Corneal Thickness (µm)	554±45.1	554.4±46	0.977
Anatomical Lens Position (mm)	3.93±0.84	4.09±0.92	0.236
Spherical Equivalent (D)	- 0.35±0.16	- 0.43±0.23	0.881

Table 4

Duration of surgery and complication data of the patients

	Group 1	Group 2	p
N	195	192	
Duration of implantation (s)	397.5±44.3	580±105.1	< 0.001
Total duration of surgery (min)	23.4 ± 2.14	27.6 ± 3.22	< 0.001
Intraocular pressure – Preoperative (mmHg)	15.7 ± 2.6	15.8 ± 2.9	0.377
Intraocular pressure - First hour (mmHg)	16.5±2.87	20.3±2.9	0.011
Intraocular pressure - Fourth hour (mmHg)	19.2±2.1	22.4±4.6	0.042
Intraocular pressure - 24th hour (mmHg)	14.1±1.3	17.5±1.8	< 0.001
Posterior capsular opacification	4 (2.1%)	28 (14.6%)	< 0.001

In the preoperative anatomical measurements of the patients, the mean axial length was 23.34±1.2 mm in group 1 and 23.24±1.3 mm in group 2. Mean anterior chamber depth was 3.19±0.46 mm in group 1 and 3.22±0.6 mm in group 2. Mean central corneal thickness was 537.8±36.2 µm in group 1 and 529.7±43.1 µm in group 2. The mean intraocular lens power calculated according to the Barrett Universal II formula was 21.5±1.8 diopters (D) in group 1 and 21.4±1.8 D in group 2. Anatomical measurements of the groups were similar (p>0.05, for all). (Table 2)

In the postoperative anatomical measurements of the patients, the mean anterior chamber depth was 3.38±0.7 mm in group 1 and 3.54±0.72 mm in group 2. Mean central corneal thickness was 554±45.1 µm in group 1 and 554.4±46 µm in group 2. Mean anatomical lens position was 3.93±0.84 mm in group 1 and 4.09±0.92 mm in group 2. Patients in group 1 had less anterior chamber depth than patients in group 2 (p=0.021). Refractive errors (spherical equivalan) were mean (-) 0.35±0.16 D in group 1 and mean (-) 0.43±0.23 D in group 2. (Table 3)

In the surgical data, the mean implantation time was 397.5±44.3 s in group 1 and 580±105.1 s in group 2. During the follow-up period (12 months), 4 patients (2.1%) in group 1 and 28 patients (14.6%) in group 2 developed posterior capsular opacification. The implantation time was shorter in group 1 than in group 2 (p<0.001) and the rate of posterior capsular opacification was lower (p<0.001) (Table 4).

Intraocular pressure measurements at the first hour after surgery averaged 16.5±2.87 mmHg in group 1 and 20.3±2.9 mmHg in group 2. At the fourth hour after surgery, the mean intraocular pressure was 19.2±2.1 mmHg in group 1 and 22.4±4.6 mmHg in group 2. At the twenty-fourth hour, the mean value was 14.1±1.3 mmHg in group 1 and 17.5±1.8 mmHg in group 2. This difference between the groups was statistically significant (p=0.011, p=0.042 and p<0.001, respectively).

4. Discussion

Each technique and stage of cataract surgery has different goals and complications. Some of these are technique-specific, while others depend on the ancillary medical supplies used. While ophthalmic viscoelastics are beneficial to the surgeon during surgery in all types of cataract surgery, they also bring certain risks in the postoperative period.

In a study conducted by Wright et al. on 46 patients, the visual results of small incision cataract surgery without the use of viscoelastic materials were quite satisfactory. However, it was emphasized that the use of viscoelastic can be used to protect the corneal endothelium[16]. Studeny et al. compared the results of standard viscoimplantation and hydroimplantation techniques. It was reported that both techniques were similar in terms of endothelial cell loss, postoperative IOP changes and complications[13].

In another study in the literature, Oğurel et al. found that hydroimplantation applied to patients with pseudoexfoliation had no adverse effect on postoperative central corneal thickness, IOP and corneal endothelial cell count compared to viscoimplantation. They also showed that IOP value 24 hours after surgery was lower in the hydroimplantation group[14].

In our study, intraocular pressure values measured at the first, fourth and twenty-fourth hours after surgery in patients who underwent hydroimplantation were found to be lower than those in the viscoimplantation group. In addition, postoperative central corneal thickness was similar between the two groups. In both techniques, no posterior capsule rupture was observed at the time of surgery. Therefore, hydroimplantation technique is an effective and safe technique. However, this technique is not recommended in eyes with posterior capsule rupture, floppy iris syndrome, irregular anterior capsulorhexis or tear. This technique should be avoided if the implanted intraocular lens is an abrupt opening or if the surgeon is not experienced enough. In accordance with the literature findings, lower intraocular pressure values were obtained in the postoperative period. The fact that it does not cause high intraocular pressure values and does not require additional cost makes this technique prominent.

Özateş et al. reported that patients who underwent hydroimplantation technique had lower refraction in the postoperative period compared to patients who underwent

viscoimplantation[15]. According to our findings, the mean postoperative refractive errors were lower in the hydroimplantation group. This may be because the anatomical lens position values were lower in the hydroimplantation group than in the viscoimplantation group. This may be due to the fact that the intraocular lens power calculated in the preoperative period was based on the estimation of the effective lens position and the patients in the hydroimplantation group were actually closer to this value.

In a study conducted by Chen et al., concluded that the hydroimplantation technique shortens the surgical time, reduces the cost of the operation and eliminates the danger of IOP elevation due to OVD[18].

Another advantage of this technique is that it can shorten the total surgical time. In a study published by Özcura and Çevik, the mean surgical time of patients who underwent hydroimplantation was significantly shorter than that of the viscoimplantation group (953.8 vs 1072.3 seconds, respectively, $p<0.001$)[17]. Oğurel et al. reported that the total surgical time was shortened by approximately three minutes[14]. In our results, the total surgical time was shortened by an average of 4.2 minutes in accordance with the literature.

This study has some limitations. The first one is that only monofocal intraocular lens implantation was performed. Other limitations include the relatively small number of patients, not including patient subgroups with different axial lengths, and not measuring intraocular pressure changes during implantation. Another limitation is that the endothelial count was not evaluated before and after surgery.

In the hydroimplantation technique, the changes in anterior segment parameters between the preoperative and postoperative period are very small. It causes less intraocular pressure elevation. Therefore, hydroimplantation is a cost-effective, safe and effective method for monofocal foldable intraocular lens implantation in uncomplicated cataract surgeries.

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Statement of ethics

This study was approved The approval of the Local Ethical Committee was obtained (Mersin City Hospital). (2022-807)

Conflict of interest statement

The authors declare that they have no financial conflict of interest with regard to the content of this report.

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