

Assessment of Differences in Pupil Size Following Phacoemulsification Surgery

Abstract

Purpose: The purpose of this study is to detect the changes in pupil size developing after phacoemulsification surgery. **Methods:** Seventy-five eyes of a total of 49 patients (32 males and 17 females) were included in this prospective clinical trial. Routine preoperative ophthalmological examinations of the patients were performed. The presence of any systemic diseases, the presence or history of ocular trauma, uveitis, optic neuropathy or anisocoria, using ocular or systemic medications, and also the presence of any other serious ocular diseases except cataract was considered as criteria for exclusion. The age range of patients included in the study is 48–81 years. Patients who developed surgical complications were excluded from the study. Pupil measurements were made after each patient waited in a dark room for 5 min preoperatively and were repeated 1 month after the operation. The Oasis brand of pupillometer was used for pupil measurement. **Results:** The mean, standard deviation, median, minimum-maximum, ratio, and frequency were used for the descriptive statistics of the data. Postoperative pupil size was seen to significantly decrease compared to the preoperative period ($P < 0.05$). The mean value of preoperative pupil size decreased from 4.9 ± 1.0 to 4.1 ± 0.9 mm 1 month after operation. **Conclusion:** The pupil size is important in phacoemulsification especially combination with phacoemulsification and multifocal intraocular lens implantation. It should be considered that better postoperative visual outcomes would be obtained by accompanying postoperative pupil size reduction into preoperative measurements. Thus, we recommend MIOLs that function independent of pupil size as appropriate for cataract surgeries in elderly patients.

Keywords: Iris, phacoemulsification, pupil, pupillometer

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Introduction

High-order (HO) aberrations are detected more frequently in subjects whose pupil size is large.^[1,2] While HO root mean square (RMS) values and spherical aberration RMS values after dilation were found to be significantly greater than before.^[3] Hashemian *et al.*, compared mesopic and >6 mm pupil HO aberrations and determined that the aberration values increased when the pupil was >6 mm in subjects who were to undergo refractive surgery.^[4] Optic aberration value increases as pupil size increases. Therefore, pupil size is important in refractive applications as refractive surgery, multifocal lens implantation, and multifocal contact lens.^[3] In this study, we evaluated the changes in pupil size before and after phacoemulsification and its outcomes.

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Methods

Randomly selected 32 males and 17 females were included in the study. The study was carried out in accordance with the tenets of the Declaration of Helsinki and was approved by the Clinical Research Ethics Committee of Haydarpasa Numune Training and Research Hospital, Istanbul. Written informed consent was obtained from all participants. Routine preoperative ophthalmological examinations of the patients were carried out. The presence of any systemic diseases, the presence or history of ocular trauma, uveitis, optic neuropathy or anisocoria, using ocular or systemic medications, and also the presence of any other serious ocular diseases except cataract was considered as criteria for exclusion. Seventy-five eyes of a total of 49 patients between the ages of 48 and 81 years were included in the study [Table 1]. All operations were performed by the same surgeon. The cases in which the iris was manipulated and who

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developed surgical complications were excluded from the study. All patients underwent implantation of the same type of intraocular lens (IOL). The topical medications used in the postoperative period (antibiotics, steroid, and anti-inflammatory drugs) and the doses were applied in the same way to all patients. Pupil measurements were made after each patient waited in a dark room for 5 min preoperatively and were repeated 1 month after the operation. The Oasis brand of pupillometer was used for the pupil measurement. The light level in the room was checked using a photometer. Each patient was made to wait in a room which had a light level of 4 cd/m² for 5 min. The pre- and post-operative measurements were made by the same team. Pupil diameter was measured at least 3 times and with the mean of the 3 consecutive consistent measurements being recorded. The mean, standard deviation, median, minimum-maximum, ratio, and frequency were used for the descriptive statistics of the data. Distribution of variables was checked using the Kolmogorov–Smirnov test. The Wilcoxon signed-rank test was used for the analysis of repeated measures. The SPSS 22.0 program (IBM Corporation, Armonk, NY, USA) was used for the analysis.

Results

The preoperative pupil size of the patients varied between 3 and 7 mm; the median of the preoperative pupil size was measured as 5 mm and the mean value was 4.9 ± 1.0 mm. The postoperative pupil sizes of the patients varied between 2.5 and 6 mm; the median of the postoperative pupil size was measured as 4 mm and the mean value was 4.1 ± 0.9 mm. The postoperative pupil size was seen to significantly decrease compared to the preoperative period ($P = 0.05$). The mean value of the reduction in the pupil size was determined 0.8 mm at 1-month postoperatively [Figure 1 and Table 2].

Table 1: Demographic and clinical characteristics of the subjects

	Median (minimum-maximum)	Mean±SD/n (%)
Age	66.0 (48.0-81.0)	65.4±7.7
Gender	Female	17 (34.7)
	Male	32 (65.3)
Eye	Right	36 (48)
	Left	39 (52.0)

SD: Standard deviation

Table 2: Descriptive statistical values of pupil size before and after operation

	Median (minimum-maximum)	Mean±SD
Pupil size		
Preoperative	5.0 (3.0-7.0)	4.9±1.0
Postoperative	4.0 (2.5-6.0)	4.1±0.9
<i>P</i>	<0.05	<0.05

SD: Standard deviation

Discussion

Presbyopia after cataract surgery can be corrected with different types of IOLs including multifocal IOL. Multifocal IOLs may be divided into two groups, as the diffractive and the refractive multifocal IOL. Diffractive IOLs are designed according to the Huygens–Fresnel principle and composed of concentric prisms placed in the anterior and posterior sides of the optic. Light bundles passing through the prisms are refracted together; both in near and far distances, and create a constructive interference, enabling focusing in near and far points. Spread and light loss may develop when the light is refracted together. Refractive IOLs have a spheric posterior surface and an anterior surface which contains annular aspheric adhesion zones. Clarity is obtained in near and far distances through the light refraction in varying degrees in certain parts. Complaints such as reduced clarity and contrast sensitivity, reflection and halo may be caused due to the superposition of the images, which are formed by varying refractive parts of the IOLs on the retina. The postoperative visual disturbances are directly related to the pupil size.^[5] One of the most important shortcomings of multifocal IOLs is their dividing the light energy for two or more images. This leads to reduced contrast sensitivity. Furthermore, ghost images are inevitably observed with multifocal IOLs. Ghost images are defined as light reflections or blurred rings. This is particularly evident in night conditions.^[6] Thus, the pupil size increases at night and related visual disturbances ascend at this time. Interaction with pupil size varies depending on various IOL brands. This lens is seen to be significantly affected by the pupil diameter when looked at from the ReZoom[®] multifocal IOL (Abbott Laboratories Inc., Illinois, USA) angle. When the use was evaluated under mesopic conditions (5 mm pupil).

ReZoom[®] has a closer (30%) and intermediate distance power (10%) and less distant power (60%). This leads to more halos and glare.^[7] Another multifocal IOL, the Acrysof[®] IQ ReStor[®] multifocal IOL (Alcon Laboratories

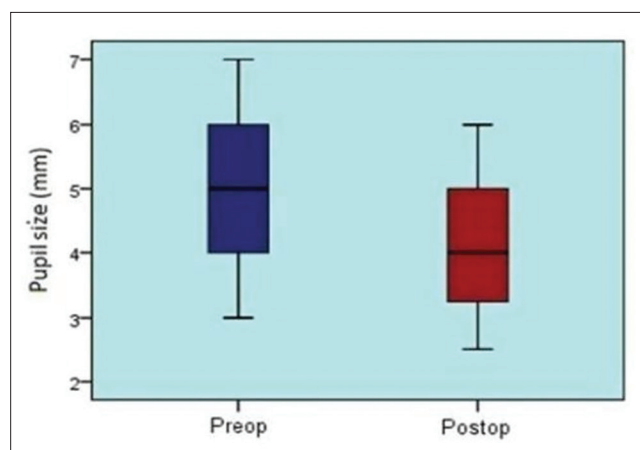


Figure 1: The mean value of reduction in the pupil size

Inc., Texas, USA) is a refractive and diffractive combined lens. The apodization technology in the diffractive part minimizes the halo effect created by the unfocused rays and increases the contrast sensitivity. The surrounding peripheral region is monofocal and provides distant vision when the pupil is dilated.^[8] The apodization technology in Acrysof[®] IQ ReStor[®] lens means a reduction of the negative effects like halo by smoothing the diffractive step transmission. In a multi-center study conducted in Europe with the MA60D3 (three piece) model, while moderate halo was observed in 25% of the patients in night conditions, severe glare was reported at the rate of 8.5%, and severe halo at the rate of 4.2% in daylight conditions.^[9] The use of diluted pilocarpine (0.125%) or brimonidine tartrate (0.15%) can resolve the problems in patients who have that type of photic problems. Furthermore, any type of halo glare is another problem, which is known to decrease in time. Under mesopic condition (5 mm pupil), different conditions arise in both lenses. Acrysof[®] IQ ReStor[®] is quite distant dominant (84%), and there is minimal near vision (10%). ReZoom[®] has more near vision (30%) and intermediate (10%) power, and less distant power (60%) develops. This means that ReZoom[®] leads to more glare and halo. In addition, near vision is worse with Acrysof[®] IQ ReStor[®] in mesopic conditions.^[7,10,11] In a study reported that phacoemulsification surgery reduced the pupil size, but this change was temporary and pupil returned to its former size at 1-month postoperatively.^[12] In another study reported that the mean change in preoperative to postoperative pupil size was < 0.5 mm and changes in pupil diameter of 1 mm or more were noted in approximately 10% of patients.^[13] In our study, the mean value of the reduction in the pupil size was determined 0.8 mm at 1 month postoperatively and this change was considered to be permanent. In another study achieved similar results reported that mean pupil diameter after dark adaptation was 5.36 mm before surgery and 4.85 mm between 30 and 60 days after surgery.^[14] Different results achieved in different studies could be associated with differences in age distribution of the patients, measurement devices, and measurement methods. The pupil size is important in appropriate cases in whom the combination with phacoemulsification and multifocal IOL implantation would be performed. This is because postoperative visual disturbances may be directly related to the pupil size. Therefore, pupil size assessment of the patients who are to undergo implantation of a multifocal lens is important. It should be considered that the pupil change will be a constriction, as better visual outcomes would be obtained by taking the pupil size into account. The limitation of the study was constraint of time; longer follow-up could further obtain different results.

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Conflicts of interest

There are no conflicts of interest.

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