

DIURNAL FLUCTUATIONS IN INTRAOCULAR PRESSURE AFTER
CATARACT PHACOEMULSIFICATION: CLINICAL SIGNIFICANCE AND
ASSESSMENT FEATURES

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Abstract

This article reviews current evidence on diurnal changes in intraocular pressure following cataract phacoemulsification. The most pronounced reduction in the amplitude of intraocular pressure fluctuations has been reported in patients with pseudoexfoliation syndrome and initially unstable ocular tone. Interpretation of the results depends on the frequency and timing of measurements, the tonometric method used, the postoperative follow-up period, and the presence of glaucoma. The limited number of contemporary studies involving comprehensive repeated 24-hour monitoring of intraocular pressure indicates the need for further investigation of this issue.

Keywords: cataract, phacoemulsification, intraocular pressure, diurnal intraocular pressure fluctuations, ocular tone, glaucoma, tonometry.

Relevance

Intraocular pressure varies throughout the day. Even in the same patient, measurements obtained in the morning, afternoon, and evening may differ. Therefore, an intraocular pressure value recorded during a single clinical visit reflects ocular tone only at the time of examination.

When evaluating the results of phacoemulsification, the mean intraocular pressure before and after surgery is most commonly compared. Although this approach is convenient, it provides only a partial representation of ocular tone. Mean intraocular pressure may decrease, whereas the maximum values or the range of diurnal fluctuations may change to a much lesser extent.

From a clinical perspective, at least four characteristics should be distinguished: mean intraocular pressure, maximum intraocular pressure, minimum intraocular

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pressure, and the amplitude of its fluctuations. Additional information can be obtained by determining the time at which the maximum intraocular pressure occurs.

Aim of the study - To analyze published data on the pattern of diurnal intraocular pressure fluctuations after cataract phacoemulsification and to determine the clinical significance of their assessment during postoperative follow-up.

Materials and Methods

The review was based on current literature concerning changes in intraocular pressure after cataract phacoemulsification.

Results and Discussion

The concepts of “mean intraocular pressure” and “diurnal intraocular pressure variability” are not equivalent.

Mean intraocular pressure reflects the overall level of ocular tone during a selected observation period, whereas diurnal variability characterizes the extent to which intraocular pressure changes over time. The simplest measure of variability is the difference between the maximum and minimum values:

Amplitude of intraocular pressure fluctuations = maximum intraocular pressure – minimum intraocular pressure.

However, even this parameter depends on how many times intraocular pressure is measured during the day.

If tonometry is performed only in the morning and evening, the resulting difference reflects the change between two time points but does not guarantee identification of the true diurnal maximum and minimum values.

The lower the frequency of measurements, the greater the probability of missing an intraocular pressure peak.

Therefore, when comparing the results of different studies, it is necessary to consider not only the magnitude of the recorded fluctuations but also the tonometry protocol itself [4].

Removal of the crystalline lens alters the anatomical relationships within the anterior segment of the eye. The anterior chamber deepens, the iridocorneal angle widens, and the influence of the crystalline lens on iris position is reduced. These changes may improve aqueous humor outflow [1, 3]. As a result, mean intraocular



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pressure often decreases after phacoemulsification. However, the effect of surgery on diurnal variability is considerably more complex.

If surgery merely shifts the entire intraocular pressure curve downward by approximately the same amount, mean, maximum, and minimum pressure values decrease, whereas the difference between the maximum and minimum values may remain almost unchanged.

If, on the other hand, surgery primarily reduces higher intraocular pressure values and attenuates pressure peaks, the amplitude of diurnal fluctuations also decreases.

Therefore, a reduction in mean intraocular pressure and a reduction in its variability should not be considered equivalent effects.

Particularly interesting contemporary data have been obtained in patients with pseudoexfoliation syndrome.

In 2020, Frankowska-Gerlak et al. investigated diurnal intraocular pressure curves in 154 patients with cataract associated with pseudoexfoliation syndrome. The patients were divided into three groups: those with normal preoperative intraocular pressure, those with ocular hypertension, and those with early primary open-angle glaucoma.

Before surgery, the amplitude of diurnal fluctuations was 5.22 ± 0.49 , 6.81 ± 1.21 , and 6.60 ± 1.49 mmHg, respectively.

After phacoemulsification with intraocular lens implantation, the amplitude decreased in all three groups. The reduction was 1.27 ± 0.93 mmHg in patients with normal baseline intraocular pressure, 2.34 ± 1.26 mmHg in patients with ocular hypertension, and 1.15 ± 1.14 mmHg in patients with early open-angle glaucoma. In all groups, the differences were statistically significant [2].

The most pronounced reduction was observed in the ocular hypertension group, in which the baseline amplitude of intraocular pressure fluctuations was relatively high.

These findings indicate that, following phacoemulsification in patients with pseudoexfoliation syndrome, not only the overall level of intraocular pressure but also the shape of the diurnal pressure curve may change.

Pseudoexfoliation syndrome occupies a special position in the assessment of diurnal ocular tone. Accumulation of pseudoexfoliative material and pigment within the trabecular meshwork is associated with impaired aqueous humor outflow. Intraocular pressure in these patients may therefore be less stable than in patients with uncomplicated age-related cataract [4].

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Accordingly, a reduction in the amplitude of intraocular pressure fluctuations after phacoemulsification may have independent clinical significance.

However, phacoemulsification should not be interpreted as an independent treatment for glaucoma in all cases. A reduction in intraocular pressure after cataract extraction does not eliminate the need for monitoring the optic nerve head, retinal nerve fiber layer, and visual field.

Even when satisfactory postoperative intraocular pressure is achieved, a patient with pseudoexfoliative glaucoma remains a patient with glaucoma and requires appropriate long-term follow-up.

In eyes with narrow or closed anterior chamber angles, the effect of lens removal has a particularly clear anatomical basis.

After phacoemulsification, the anterior chamber becomes deeper and the iridocorneal angle widens. Contemporary studies confirm a reduction in intraocular pressure after lens extraction in patients with primary angle closure and angle-closure glaucoma.

Comparison of intraocular pressure before and after surgery is meaningful only when measurements are obtained under comparable conditions.

If preoperative intraocular pressure is measured in the morning and postoperative pressure in the afternoon, part of the observed difference may be attributable to normal diurnal variation.

In some studies, the term “diurnal variability” has been used when intraocular pressure was measured only in the morning and evening. This approach allows the difference between two measurements to be determined but does not reproduce a complete 24-hour profile.

The true intraocular pressure maximum may occur between the selected measurement times or during nighttime hours.

Therefore, the results of studies based on two daily measurements cannot be directly compared with studies in which tonometry was performed every few hours.

This distinction is particularly important when developing a prognostic model, because the accuracy of variability assessment depends directly on measurement frequency.

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The first 24 hours after phacoemulsification have specific characteristics. Intraocular pressure may be influenced by residual viscoelastic material, postoperative inflammation, tissue edema, and other factors directly related to surgery.

Therefore, a high intraocular pressure value during the first postoperative hours should not automatically be regarded as part of the patient's usual diurnal rhythm.

An early postoperative intraocular pressure spike and persistent diurnal variability are different phenomena.

To evaluate the established postoperative intraocular pressure profile, measurements performed after the early recovery period are more informative, when the influence of immediate surgical factors has diminished.

Assessment of the diurnal intraocular pressure profile after phacoemulsification is not required in every patient.

In uncomplicated cataract without glaucoma and with stable ocular tone, repeated tonometry at standard follow-up visits generally provides sufficient information.

More intensive monitoring is more justified in patients with glaucoma, ocular hypertension, pseudoexfoliation syndrome, marked differences between consecutive intraocular pressure measurements, or a discrepancy between measured intraocular pressure and the condition of the optic nerve.

Conclusion

Cataract phacoemulsification may affect not only the mean intraocular pressure but also the pattern of its diurnal fluctuations. The most pronounced reduction in fluctuation amplitude has been described in patients with pseudoexfoliation syndrome, ocular hypertension, and high baseline intraocular pressure variability. However, a decrease in mean postoperative intraocular pressure is not necessarily accompanied by a reduction in its diurnal variability. Mean, maximum, and minimum intraocular pressure values, as well as the amplitude of fluctuations, should therefore be evaluated separately. For reliable longitudinal assessment, the same tonometric method should be used and measurements should be performed at comparable times of day. Evaluation of the diurnal intraocular pressure profile is particularly important in patients with glaucoma, pseudoexfoliation syndrome, and ocular hypertension. The limited number of standardized studies highlights the need for further investigation of the effect of phacoemulsification on diurnal intraocular pressure dynamics.

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