

**CORNEAL BIOMECHANICAL PROPERTIES AND THEIR
SIGNIFICANCE IN THE ASSESSMENT OF INTRAOCULAR PRESSURE
AFTER CATARACT PHACOEMULSIFICATION**

**MAMATKHUJAEVA GULNARAHAN NAJMIDINOVNA
MUHAMMADJONOV OLIMJON ODILJON UGLI**

Andijan State Medical Institute (Andijan, Uzbekistan)

Abstract. The article reviews current evidence on changes in corneal biomechanical properties following phacoemulsification and their influence on the interpretation of intraocular pressure measurements. Central corneal thickness, corneal hysteresis, corneal resistance factor, dynamic deformation parameters, and intraocular pressure values corrected for corneal biomechanics are analyzed. In the early postoperative period, changes in biomechanical parameters are largely associated with surgical intervention and postoperative corneal edema.

When interpreting postoperative intraocular pressure, it is necessary to consider not only the value obtained by tonometry but also the measurement method, the time elapsed after surgery, central corneal thickness, and the biomechanical characteristics of the cornea. This approach is particularly important in patients with glaucoma and ocular hypertension.

Keywords: cataract, phacoemulsification, intraocular pressure, corneal biomechanics, tonometry.

Introduction

Monitoring intraocular pressure is an essential component of follow-up after cataract phacoemulsification. During the first hours and days after surgery, it allows timely detection of elevated intraocular pressure, while during subsequent follow-up it provides an opportunity to assess its long-term dynamics. The accuracy of intraocular pressure measurements is particularly important in patients with glaucoma and ocular hypertension, in whom even relatively small differences in intraocular pressure values may influence the assessment of treatment effectiveness and further follow-up strategy.

At the same time, the value obtained by tonometry cannot be considered fully equivalent to the true intraocular pressure. Most commonly used methods are based on

CONFERENCE ON FRONTIERS OF SCIENCE AND ENGINEERING • QATAR •

mechanical interaction with the cornea. Therefore, the measurement result depends not only on the pressure inside the eye but also on corneal thickness, viscoelastic properties, stiffness, and deformation behavior.

Aim of the study-To analyze current evidence on changes in the biomechanical properties of the cornea after cataract phacoemulsification and to determine their significance for the interpretation of postoperative intraocular pressure.

Materials and Methods

The review was based on current literature data concerning corneal changes after phacoemulsification and the characteristics of intraocular pressure measurement during the postoperative period.

Results and Discussion

The cornea is not a passive оболочка but a tissue with complex elastic and viscoelastic properties. When exposed to an air pulse or an applanation load, it undergoes deformation, the characteristics of which depend on its structure and mechanical state.

With the introduction of the Ocular Response Analyzer into clinical practice, two parameters have become widely used: corneal hysteresis and corneal resistance factor.

Corneal hysteresis characterizes the ability of the cornea to absorb and dissipate energy during deformation. The corneal resistance factor is more closely associated with the overall resistance of the cornea to mechanical stress. Both parameters depend on the condition of the tissue but reflect different aspects of its mechanical behavior.

Corvis ST assesses corneal biomechanics using a different approach. A high-speed Scheimpflug camera records changes in corneal shape during exposure to an air pulse. Parameters analyzed include deformation velocity and amplitude, the radius of curvature at maximum concavity, stiffness parameters, and a number of derived indices.

This approach is particularly useful after ocular surgery, when corneal thickness and mechanical properties may change simultaneously.

Hirasawa et al. examined 39 eyes before surgery and subsequently at one week, one month, and three months after surgery using Corvis ST. The authors evaluated deformation amplitude, stiffness parameters, central corneal thickness, uncorrected intraocular pressure, and biomechanically corrected intraocular pressure. Following surgery, changes were observed in both intraocular pressure measurements and the characteristics of the corneal mechanical response [1]. This study demonstrated that

CONFERENCE ON FRONTIERS OF SCIENCE AND ENGINEERING • QATAR •

postoperative changes cannot be explained solely by an increase or decrease in corneal thickness. The biomechanical response of the cornea has its own postoperative dynamics.

Wallace et al. conducted a prospective study using Corvis ST. Measurements were performed before surgery and three months after phacoemulsification. A total of 93 eyes were included in the final analysis.

At three months, the mean biomechanically corrected intraocular pressure was 3.63 mmHg lower than the preoperative value. At the same time, central corneal thickness increased by an average of 6.96 μm . Independently of changes in intraocular pressure and pachymetry, the stiffness parameter at first applanation decreased, whereas some corneal deformation parameters increased [5].

These findings indicate that changes in the mechanical response of the cornea may persist for several months after surgery and cannot be explained solely by early postoperative corneal edema.

Differences between methods of intraocular pressure measurement become particularly important when corneal properties change.

Goldmann applanation tonometry, non-contact tonometry, the Ocular Response Analyzer, and Corvis ST are based on different physical principles or different approaches to signal processing. Therefore, postoperative changes in the cornea do not necessarily affect the results obtained with these methods to the same extent.

In the study by Sedaghat et al., biomechanically corrected intraocular pressure measured using Corvis ST was compared with Goldmann applanation tonometry, Icare tonometry, and corneal-compensated intraocular pressure obtained with the Ocular Response Analyzer. Systematic differences were found between the methods, with the closest agreement observed between biomechanically corrected intraocular pressure and corneal-compensated intraocular pressure [4].

The study by Ma et al. also demonstrated differences between biomechanically corrected intraocular pressure measured with Corvis ST and conventional non-contact tonometry and confirmed that corneal biomechanical characteristics influence intraocular pressure measurements [3].

Therefore, during postoperative follow-up after phacoemulsification, it is preferable to use the same method of tonometry. Comparison of measurements obtained with different tonometers may introduce an additional source of error.

CONFERENCE ON FRONTIERS OF SCIENCE AND ENGINEERING QATAR

One approach aimed at reducing the influence of corneal properties on measurement results is the determination of biomechanically corrected intraocular pressure.

The Corvis ST algorithm calculates this parameter using the characteristics of dynamic corneal deformation. Compared with conventional tonometric values, biomechanically corrected intraocular pressure is less dependent on certain corneal characteristics.

The most comprehensive summary of published evidence was provided in the systematic review and meta-analysis by Li et al., published in 2025. The analysis included 13 studies identified through searches of PubMed, EMBASE, Web of Science, and ClinicalTrials.gov [2].

Following phacoemulsification, pooled analysis demonstrated an increase in central corneal thickness of 10.50 μm . Corneal hysteresis decreased by an average of 0.43 mmHg, whereas the corneal resistance factor decreased by 0.49 mmHg. The change in Goldmann-correlated intraocular pressure was also statistically significant.

A different pattern was observed for corneal-compensated intraocular pressure. The mean difference was -0.13 mmHg and was not statistically significant.

This discrepancy between the parameters is particularly informative. If postoperative tonometric changes were determined solely by actual changes in pressure within the eye, more similar behavior of different measurement methods could be expected. The differences between Goldmann-correlated intraocular pressure and corneal-compensated intraocular pressure further support the role of the cornea in determining the measured intraocular pressure value.

Ye et al., comparing biomechanically corrected intraocular pressure obtained with Corvis ST and Goldmann applanation tonometry in patients with open-angle glaucoma and ocular hypertension, showed that values obtained using different methods may differ [6].

Therefore, after phacoemulsification in a patient with glaucoma, the effectiveness of intraocular pressure control should not be assessed solely on the basis of a small reduction in a single tonometric parameter, particularly when corneal thickness or biomechanical properties have changed simultaneously.

Data obtained with Corvis ST indicate that some alterations in corneal stiffness and deformation response may persist for at least three months after phacoemulsification [1, 5].

CONFERENCE ON FRONTIERS OF SCIENCE AND ENGINEERING • QATAR •

For dynamic follow-up, intraocular pressure should preferably be measured using the same method. When the measurement is particularly important for treatment decisions in a patient with glaucoma or ocular hypertension, tonometric findings should be interpreted together with central corneal pachymetry and, when appropriate equipment is available, with an assessment of corneal biomechanical parameters.

Conclusion

Cataract phacoemulsification is accompanied by changes in both intraocular pressure and the biomechanical properties of the cornea, which should be taken into account when interpreting tonometric measurements. During the early postoperative period, intraocular pressure readings may be influenced by transient corneal edema; however, alterations in the mechanical properties of the cornea may persist even after restoration of corneal transparency. Central corneal thickness, corneal hysteresis, and corneal resistance factor remain important parameters for assessment, while the use of Corvis ST additionally enables evaluation of dynamic corneal deformation and biomechanically corrected intraocular pressure. The reduction in measured intraocular pressure after surgery is associated not only with changes in corneal properties but also with remodeling of anterior segment anatomy and improved aqueous humor outflow.

References

1. Hirasawa K, Nakakura S, Nakao Y, Fujino Y, Matsuura M, Murata H, et al. Changes in corneal biomechanics and intraocular pressure following cataract surgery. *Am J Ophthalmol*. 2018;195:26–35. doi:10.1016/j.ajo.2018.07.025.
2. Li X, Li X, Tan L, Chen H, Lai Y. The corneal biomechanical changes of phacoemulsification in cataract patients: a systematic review and meta-analysis. *PLoS One*. 2025;20(1). doi:10.1371/journal.pone.0317179.
3. Ma J, Wang Y, Hao W, Jhanji V. Comparative analysis of biomechanically corrected intraocular pressure with corneal visualization Scheimpflug technology versus conventional noncontact intraocular pressure. *Int Ophthalmol*. 2020;40(1):117–124. doi:10.1007/s10792-019-01159-9.
4. Sedaghat MR, Momeni-Moghaddam H, Yekta AA, Elsheikh A, Khabazkhoob M, Ambrósio R Jr, et al. Biomechanically-corrected intraocular pressure compared to

CONFERENCE ON FRONTIERS OF SCIENCE AND ENGINEERING QATAR

pressure measured with commonly used tonometers in normal subjects. Clin Optom (Auckl). 2019;11:127–133. doi:10.2147/OPTO.S220776.

5. Wallace HB, Misra SL, Li SS, McKelvie J. Biomechanical changes in the cornea following cataract surgery: a prospective assessment with the Corneal Visualisation Scheimpflug Technology. Clin Exp Ophthalmol. 2019;47(4):461–468. doi:10.1111/ceo.13451.

6. Ye Y, Yang Y, Fan Y, Lan M, Yu K, Yu M. Comparison of biomechanically corrected intraocular pressure obtained by Corvis ST and Goldmann applanation tonometry in patients with open-angle glaucoma and ocular hypertension. J Glaucoma. 2019;28(10):922–928. doi:10.1097/IJG.0000000000001348.

