journal of clinical practice 2025 Vol 16 №2

Implantation of an Additional Intraocular Lens for Keratoconus in a Pseudophakic Eye

A.D. Chuprov, V.L. Kim, I.A. Stolyar
The S. Fyodorov Eye Microsurgery Federal State Institution, Orenburg branch, Orenburg, Russia

ABSTRACT

BACKGROUND: *In the accessible literature sources, there is insufficient information on the correction of refraction abnormalities in cases of keratoconus, due to which exploring the modern approaches in the implantation of additional intraocular lenses, including the choice of indications, the surgical technique and the post-operative follow-up, gains major importance for managing the patients with this disease.* ***CLINICAL CASE DESCRIPTION:*** *The patient G., aged 42 years, presented with the complaints of decreased visual acuity in the left eye. Past medical history of progressing decreased visual acuity in both eyes from 2018, the diagnosis set was the following: "Right eye (OD): keratoconus stage I, left eye (OS): keratoconus stage II". In 2018, the implantation of intrastromal corneal ring segments in both eyes was conducted, in 2019 — refractive lensectomy with the implantation of the AcrySof IQ Toric SN6AT8 intraocular lens (Alcon, USA) in both eyes. The examination results in the OS upon presenting were the following: non-corrected visual acuity 0.05, maximum corrected visual acuity 0.5; autorefractometry: sph +2.25 D; cyl -9.50 D ax 81°; intraocular pressure — 17 mm.Hg. For correcting the refractive error that is preventing from achieving the high visual acuity (far vision), the implantation of additional intraocular lenses was carried out (Sulcofix Toric Care group, India). The results of examining the OS during the first 24 hours after surgery were the following: non-corrected visual acuity of the OS 0.8; autorefractometry: sph -0.25 D; cyl -14.50 D ax 81°; intraocular pressure — 17 mm.Hg.* ***CONCLUSION:*** *The implantation of additional Sulcofix Toric intraocular lenses have demonstrated its efficiency in correcting the refractive error in the pseudophakic eye with keratoconus, however, due to the irregular astigmatism characteristic for keratoconus, the residual defect can still persist.*

Keywords: *additional intraocular lenses; IOL; pseudophakia; keratoconus; residual ametropia; additional correction; clinical case.*

For citation:
Chuprov AD, Kim VL, Stolyar IA. Implantation of an Additional Intraocular Lens for Keratoconus in a Pseudophakic Eye. *Journal of Clinical Practice*. 2025;16(2):119–126. doi: 10.17816/clinpract677794
EDN: EVYMUF

Submitted 27.03.2025 Accepted 28.06.2025 Published online 08.07.2025

List of abbreviations

IOL — intraocular lens
MCVA — maximum corrected visual acuity
NCVS — non-corrected visual acuity
Ax (axis) — the axis of the cylinder measured in degrees (from 0 to 180)
Cornea back — posterior surface of the cornea
Cornea front — anterior surface of the cornea
Cyl (cylinder) — optical power of the cylinder
K1 and K2 — keratometry values in the anterior part of the cornea: K1 — flat, K2 — steep
OD (oculus dexter) — right eye
OS (oculus sinister) — left eye
Sph (sphere) — value of the optic power of the lens, expressed in diopters (dioptria, D)

BACKGROUND

The topicality of the research devoted to the implantation of the additional intraocular lens (aIOL) for keratoconus is resulting from several key factors. First of all, keratoconus represents a progressing dystrophic disease of the cornea, which is characterized by its thinning and bulging into the central and/or the paracentral areas, which leads to the development of irregular astigmatism, decreased visual acuity and significant aggravation of the quality of life among the patients [1].

Имплантация добавочной интраокулярной линзы при кератоконусе на артифакичном глазу

А.Д. Чупров, В.Л. Ким, И.А. Столяр

Национальный медицинский исследовательский центр «Межотраслевой научно-технический комплекс «Микрохирургия глаза» имени академика С.Н. Федорова», Оренбургский филиал, Оренбург, Россия

АННОТАЦИЯ

Обоснование. *В доступных источниках литературы недостаточно информации по коррекции аномалий рефракции при кератоконусе, в связи с чем изучение современных подходов к имплантации добавочных интраокулярных линз, включая выбор показаний, технику операции и постоперационное наблюдение, имеет важное значение.* ***Описание клинического случая.*** *Пациент Г., 42 года, обратился с жалобами на снижение зрения на левом глазу. В анамнезе с 2018 года прогрессирующее снижение остроты зрения на оба глаза, выставлен диагноз: «Правый глаз (OD): кератоконус I стадии, левый глаз (OS): кератоконус II стадии». В 2018 году проведена имплантация интрастромальных роговичных сегментов на оба глаза, в 2019 году — рефракционная ленсэктомия с имплантацией интраокулярной линзы на оба глаза. Результаты обследования OS при обращении: некорригированная острота зрения 0,05, максимально корригированная острота зрения 0,5; авторефрактометрия: sph +2,25 D; cyl -9,50 D ax 81°; внутриглазное давление 17 мм рт.ст. Для коррекции аномалии рефракции, препятствующей достижению высокой остроты зрения вдаль, выполнена имплантация добавочных интраокулярных линз. Результаты обследования OS в первые сутки после операции: некорригированная острота зрения OS 0,8; авторефрактометрия: sph -0,25 D; cyl -14,50 D ax 81°; внутриглазное давление 17 мм рт.ст.* ***Заключение.*** *Имплантация добавочных интраокулярных линз продемонстрировала свою эффективность в коррекции аномалии рефракции на артифакичном глазу с кератоконусом, однако из-за нерегулярного астигматизма, характерного для кератоконуса, остаточный дефект всё же может сохраняться.*

Ключевые слова: *добавочные интраокулярные линзы; ИОЛ; артифакия; кератоконус; остаточная аметропия; докоррекция; клинический случай.*

Для цитирования:

Чупров А.Д., Ким В.Л., Столяр И.А. Имплантация добавочной интраокулярной линзы при кератоконусе на артифакичном глазу. *Клиническая практика.* 2025;16(2):119–126. doi: 10.17816/clinpract677794 EDN: EVYMUF

Поступила 27.03.2025 Принята 28.06.2025 Опубликована online 08.07.2025

The occurrence rates of keratoconus in European population ranges from 5 to 23 cases per 100 000 residents with the mean worldwide rate of 54 per 100 000 [2]. The disease affects the representatives of all the ethnicities and both genders. Usually, the symptoms of keratoconus start to manifest in the adolescence years. Higher rate of occurrence is observed among the Asian-looking individuals [3]. The early research has revealed that the disease is more commonly observed in women — 52.9% as compared to 47.1% in men [2]. During the last two decades, a growth is reported in the number of registered cases, which can be explained by the improvement of diagnostic methods and by the increased detectability of the early disease stages.

Traditional methods of optic correction for keratoconus, such as glasses and contact lenses, often become ineffective at the later stages of the disease. The progressing irregular astigmatism results in the discomfort, the intolerability of lenses and unstable refraction. The surgical treatment methods [4, 5], including the corneal crosslinking, the implantation of intrastromal corneal ring segments and various keratoplasty variants, do not always provide sufficient correction of ametropy [6–8].

Taking into consideration that the percentage of young men among the keratoconus patients is sufficiently high, special topicality gains the achieving the good visual function and preserving the vision quality in the long-term perspective. The implantation of aIOL in the settings of correct selection of the optic power and thorough assessment of the status of the cornea, of the depth of the anterior chamber and of the

https://doi.org/10.17816/clinpract677794

journal of clinical practice 2025 Vol 16 №2

keratoconus progression level can significantly improve the quality of life for the patients, with improving their social adaptation and professional relevance. For the success of such surgeries, it is necessary to follow the specific criteria, in particular, the stability of keratoconus within not less than a year along with the presence of transparent cornea at the optic zone [7].

In the accessible literature sources, there is insufficient information on the correction of refraction abnormalities in cases of keratoconus, due to which exploring the modern approaches in the implantation of aIOL, including the choice of indications, the surgical technique and the post-operative follow-up, gains major importance for managing the patients [9–11]. The analysis of clinical results after such interventions allows for evaluating their clinical efficiency, as well as for defining the remote consequences for patients [12, 13].

In this article, describing the clinical case, an assessment was carried out of the efficiency of intraocular correction of ametropy using the implantation of an additional intraocular lens in a patient with pseudophakia and grade I–II keratoconus.

CLINICAL CASE DESCRIPTION

Patient information

Patient G., aged 42 years, presented to the Orenburg affiliated branch of the Federal State Autonomous Institution «NMRC «Interdisciplinary Scientific and Technical Complex “Eye Microsurgery” named after the academician S.N. Fedorov» under the Ministry of Health of the Russian Federation with the complaints of decreased visual acuity in the left eye.

Disease history. From 2018, the patient reports the progressing decrease of visual acuity in both eyes, especially in the left one. The patient was diagnosed with the following diseases: “OD — keratoconus stage I, OS — keratoconus stage II”. In 2018, implantation of the intrastromal corneal ring segments was done in both eyes. For the purpose of improving the visual acuity, according to the will of the patient, in 2019 he underwent a lensectomy (refractive replacement of the eye lens) with an implantation of the intraocular lens (IOL) in both eyes, however, due to the past history of operated keratoconus, the target refraction was not achieved. The surgery was done using the standard method of ultrasonic phacoemulsification of the cataract with the implantation of IOL by means of the EVA surgical system (DORC, The Netherlands). The implanted intraocular lens was the AcrySof IQ Toric SN6AT8 +20.0 (Alcon, USA).

The non-corrected visual acuity (NCVA) before surgical intervention in the left eye was 0.05, maximum corrected visual acuity (MCVA) — 0.2.

Autorefractometry: sph +4.5, cyl -10.25, ax 80°. Intraocular pressure — 13 mm.Hg.

NCVA after surgery in the left eye was 0.05, MCVA — 0.5.

Autorefractometry: OS — sph +1.5; cyl -9.5 ax 86°. Intraocular pressure — 17 mm.Hg.

laboratory and instrumental diagnostics

The patient underwent a standard ophthalmology examination, including the pre- and postoperative visometry, namely the following: NCVA and MCVA, refractometry, ophthalmometry, perimetry, keratopachymetry, tonometry, biomicroscopy, gonioscopy, ophthalmoscopy, endothelial microscopy, optic biometry and corneal topography. The measurements of NCVA and MCVA were carried out using the CV-3000 phoropter with ACP5 chart panel manufactured by Topcon (Japan). The analysis of the anterior and the posterior elevation of the cornea, as well as the measurements of corneal thickness and the depth of the anterior chamber (ACD) were conducted using the Scheimpflug-topography device from Pentacam (Germany). The endothelial microscopy was performed using the TOMEY EM-3000 contacted and non-contacted endothelial microscope (Tomey, Japan), while the optical coherent tomography was done by means of using the Optovue SOLIX device (Optovue, USA).

NCVA — 0.05; MCVA — 0.5. Autorefractometry results: OS (sph +2.25 D; cyl -9.50 D ax 81°); intraocular pressure 17 mm.Hg.

Provisional diagnosis

Bases on the examination results, the diagnosis set was the following: “H16.8 OS Keratoconus. Status post implantation of the intrastromal corneal ring segments. Induced mixed astigmatism. Pseudophakia. Amblyopia of medium degree of severity. H16.8 OD Keratoconus. Status post implantation of the intrastromal corneal ring segments. Induced mixed astigmatism. Pseudophakia”.

Treatment

In order to correct the refractive error preventing from achieving the high visual acuity (far vision), an implantation of the aIOL Sulcofix Toric was carried out (sph — 3.0 D, cyl +6.0 D) (Care Group, India).

The surgical access was gained by means of the main corneal tunnel incision with a diameter of 2.2 mm at the 3 o'clock position and via the two auxiliary corneal incisions with a diameter of 1.2 mm at the 1 and 7 o'clock positions. The anterior chamber was refilled with viscoelastic media — the 2% solution of hypromellose (Appavisc, India). The completion of surgery included the bimanual removal of the remaining viscoelastic gel and the hydration of the corneal incisions. The surgery was conducted using the EVA surgical system (DORC, The Netherlands).

Follow-up and outcomes

The assessment and examination conducted during the first 24 hours after surgery, have demonstrated the transparent smooth cornea, the presence of intrastromal corneal ring segments, the hermetically sealed corneal incisions, the deep anterior chamber, the unremarkable iris, as well as the correct position of the aIOL and of the posterior chamber IOL. The vitreous body and the ocular fundus show no signs of abnormalities. NCVA OS 0.8 n.c.

Autorefractometry results: OS (sph -0.25 D; cyl -14.50 D ax 81°). Intraocular pressure — 17 mm.Hg.

Keratometry findings (Pentacam, Germany) OS. Cornea front (anterior surface of the cornea): K1 36.4 D, ax 82°; K2 46.6 D, ax 172°. Astigmatism (Astig.) 10.2 D. Cornea back (posterior surface of the cornea): K1 - 5.3 D; K2 - 6.6 D. Astig. 1.3 D (Fig. 1).

One month after surgery, the assessment and examination show that the cornea is transparent and smooth; the intrastromal corneal ring segments were clearly detected, the corneal incisions are sealed, the anterior chamber is deep, the iris is unremarkable, the aIOL is correctly positioned, just like the IOL in the posterior chamber. The vitreous body and the ocular fundus show no signs of abnormalities (Fig. 2).

NCVA in the OS was 0.5, MCVA in the OS — 0.5 cyl -2.0 D ax 100° = 0.7.

Autorefractometry results. OS: sph -0.25 D; cyl -2.0 D ax 100°. Intraocular pressure — 19 mm.Hg.

Keratometry findings (Pentacam, Germany) OS. Cornea front: K1 38.6 D, ax 87°; K2 45.1 D, ax 177°. Astig. 6.5 D. Cornea back: K1 -5.5 D; K2 -6.4 D. Astig. 0.8 D (Fig. 3).

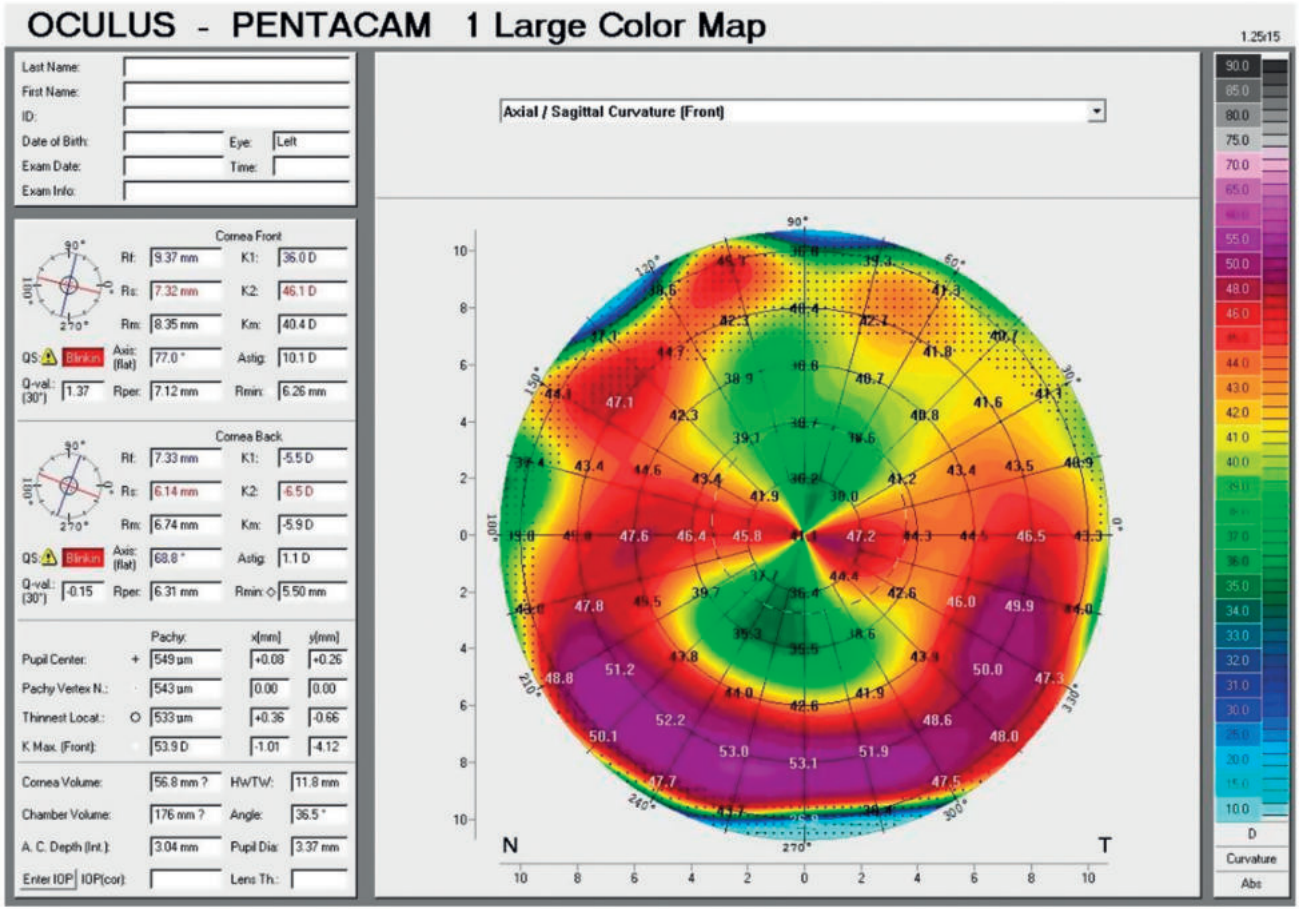

Fig. 1. Keratotopography image of the left eye before surgical intervention.

https://doi.org/10.17816/clinpract677794

journal of clinical practice 2025 Vol 16 №2

Definitive diagnosis

The following clinical diagnosis was set to the patient: "H16.8 OS Keratoconus. Status post implantation of the intrastromal corneal ring segments. Induced mixed astigmatism. Pseudophakia. Amblyopia of medium degree of severity. H16.8 OD Keratoconus. Status post implantation of the intrastromal corneal ring segments. Induced mixed astigmatism. Pseudophakia".

Prognosis

The achieved results indicate the favorable outcome: preserved transparency of the optical media, physiological values of intraocular pressure (17–19 mm.Hg.), as well as stable refraction, allowing to consider the combined approach with the using toral aIOL an effective solution for correcting the severe astigmatism in patients with keratoconus after previous surgical interventions. Such a combination of methods increases the chances of stabilizing the visual functions and of improving the quality of life.

Despite the positive effect, taking into consideration the potential progression of keratoconus, regular topography and clinical monitoring is necessary, especially in the relatively early post-surgery period.

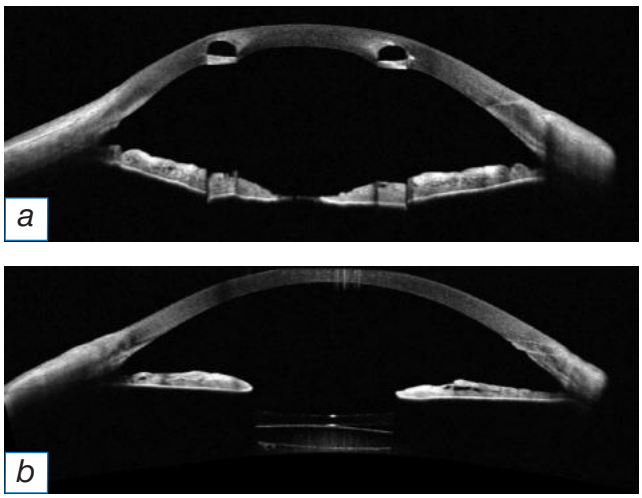

Fig. 2. Optical coherent tomography of the left eye after surgical intervention: *a* — intrastromal corneal ring segment; *b* — the posterior chamber shows the presence of an additional intraocular lens and of the posterior chamber intraocular lens.

DISCUSSION

The results obtained during the present research indicate that the implantation of aIOL can be effectively and safely used in adult patients. In the research works

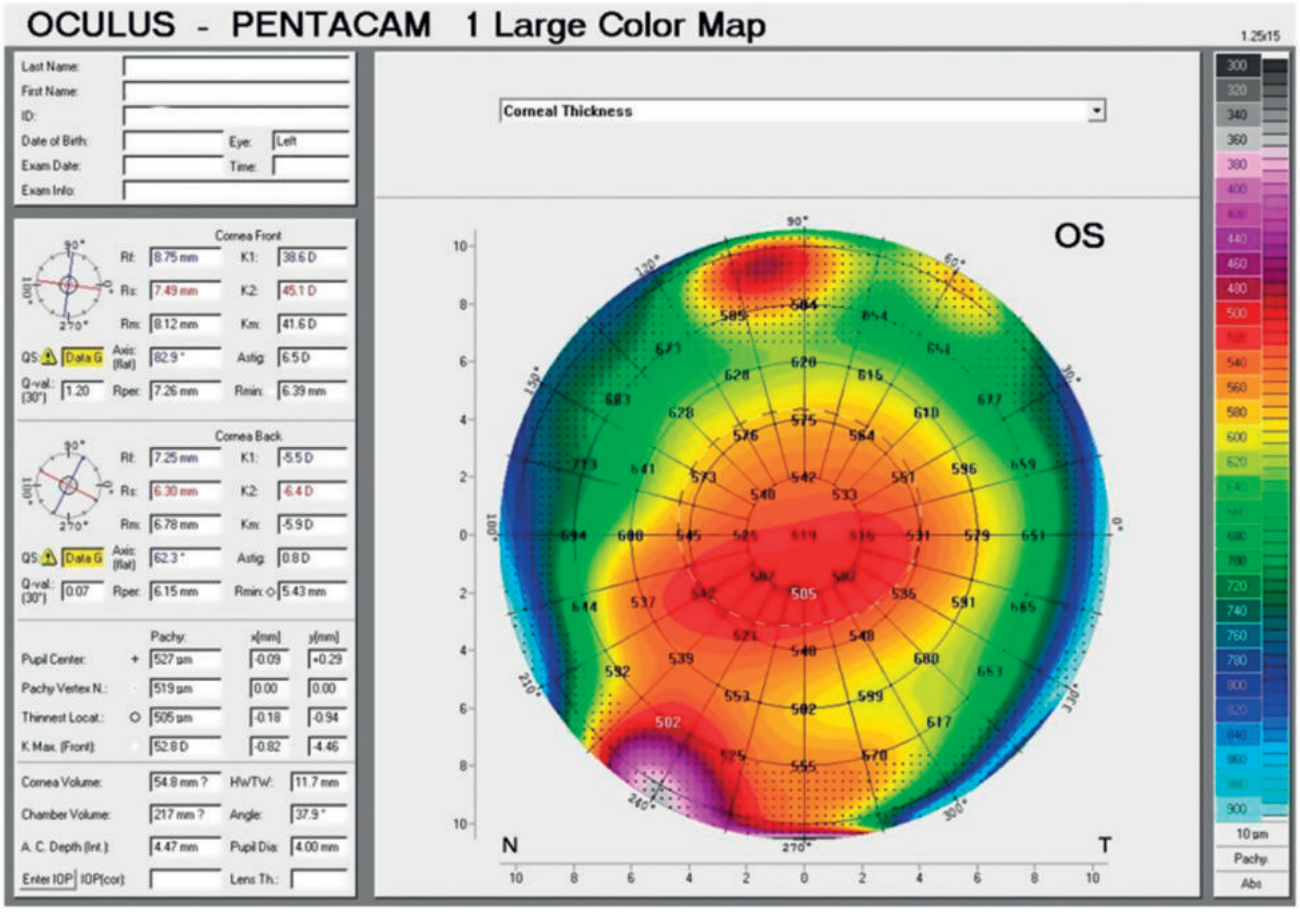

Fig. 3. Keratotopography image of the left eye after surgical intervention.

arranged in our country, the implantation of aIOL is also possible in children. Despite the fact that the demonstrated technology has still not gained wide spreading in our country, the data on the insignificant loss of endothelial cells (not more than 3%), as well as on preserving the intraocular pressure and outflow facility values within the normal ranges in patients after surgery are promising [11].

From the point of view of refractive efficiency, additional implantation of non-spherical or toric IOL allows for achieving the stable optical result for a short time, which meets the modern requirements for cataract surgery and for refractive procedures. The high accuracy of calculations and the ease of performing the surgery, as well as the specific features of the lens structure, provide its stable fixation in the iridociliary sulcus, which eventually provides the stability of the refractive effect and the absence of interactions between the surfaces of the main and the additional IOL. Such parameters are important both for the patients with ametropy after the phacoemulsification of the cataract and for the children with congenital abnormalities of the eye lens, requiring the correction of refraction [11, 14].

Thus, the results of the present research together with the literature data show the perspectivity of using the aIOL for correcting ametropy and increasing the vision quality after cataract phacoemulsification, nevertheless, further accumulation of clinical experience and arranging additional comparative research is necessary with longer follow-up period and more extensive patient samples. This shall allow for better evaluation of the remote refraction stability, the possible changes in the topography of the anterior ocular segment, as well as to compare the efficiency of various aIOL models in various clinical settings.

CONCLUSION

The implantation of the Sulcofix Toric aIOL have demonstrated its efficiency in correcting the refractive abnormalities in the pseudophakic eye with keratoconus, however, due to the irregular astigmatism, characteristic for keratoconus, the residual defect can still persist. The substantial clinical effect is demonstrated by the combined approach to the treatment of keratoconus, with this, the patient requires regular topography and clinical control for the timely detection of possible disease progression.

ADDITIONAL INFORMATION

Author contributions. *A.D. Chuprov:* concept and design of the study, *V.L. Kim:* surgical treatment and examination of the patient; *I.A. Stolyar:* processing of the study results, writing the text of the article. The authors made a substantial contribution to the conception of the work, acquisition, analysis, interpretation of data for the work, drafting and revising the work, final approval of the version to be published and agree to be accountable for all aspects of the work.

Consent for publication. The authors received written informed voluntary consent from the patient to publish personal data, including photographs (with the face covered), in a scientific journal, including its electronic version (date of signing: 22.01.2025). The volume of published data was agreed upon with the patient.

Funding sources. No funding.

Disclosure of interests. The authors have no relationships, activities or interests for the last three years related with for-profit or not-for-profit third parties whose interests may be affected by the content of the article.

Statement of originality. The authors did not utilize previously published information (text, illustrations, data) in conducting the research and creating this paper.

Data availability statement. The editorial policy regarding data sharing does not apply to this work, data can be published as open access.

Generative AI. Generative AI technologies were not used for this article creation.

Provenance and peer-review. This paper was submitted to the journal on an initiative basis and reviewed according to the usual procedure. Two external reviewers and the scientific editor of the publication participated in the review.

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AUTHORS' INFO

The author responsible for the correspondence:
Irina A. Stolyar;
address: 17 Salmyshskaya st, Orenburg, Russia, 460047;
ORCID: 0009-0001-0289-5640;
eLibrary SPIN: 3412-9967;
e-mail: nauka@ofmntk.ru

Co-authors:
Aleksandr D. Chuprov, MD, PhD, Professor;
ORCID: 0000-0001-7011-4220;
e-mail: nauka@ofmntk.ru

Vitaliy L. Kim;
ORCID: 0000-0001-6726-0104;
eLibrary SPIN: 6790-9444;
e-mail: nauka@ofmntk.ru

ОБ АВТОРАХ

Автор, ответственный за переписку:
Столяр Ирина Андреевна;
адрес: Россия, 460047, Оренбург, ул. Салмышская, д. 17;
ORCID: 0009-0001-0289-5640;
eLibrary SPIN: 3412-9967;
e-mail: nauka@ofmntk.ru

Соавторы:
Чупров Александр Дмитриевич, д-р мед. наук, профессор;
ORCID: 0000-0001-7011-4220;
e-mail: nauka@ofmntk.ru

Ким Виталий Леонидович;
ORCID: 0000-0001-6726-0104;
eLibrary SPIN: 6790-9444;
e-mail: nauka@ofmntk.ru