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The influence of intraocular lens dislocation surgical correction method on corneal endothelium

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BACKGROUND: Intraocular lens (IOL) dislocation is a rare but serious complication of surgical treatment of patients with cataract. Among the factors contributing to its development, the main ones are pseudoexfoliation syndrome (PEX), high axial myopia, chronic uveitis, history of eye injury and age. There is no universal IOL dislocation correction technique.

PURPOSE: To evaluate the impact on corneal endothelium of two different methods of IOL dislocation correction: IOL repositioning with transscleral suture fixation or IOL exchange to iris-claw one.

MATERIALS AND METHODS: Within the study, 78 patients were examined and operated. All patients were divided into two groups: in the first group, IOL was repositioned with transscleral suture fixation, and in the second group IOL was exchanged to iris-claw IOL. Groups were equal by gender and age. Key estimated indicators were endothelial cell density and coefficient of variation reflecting the degree of polymegatism.

RESULTS: Endothelial cell density was significantly lower both before surgery and at any term after it, in the group with IOL exchange, and coefficient of variation was significantly higher in the group with IOL exchange throughout this study.

CONCLUSION: The choice of technique for IOL dislocation correction is the basis of success in surgical treatment. Certain preoperative examination data should be definitely considered, including the degree of dislocation, IOL type, IOP level, endothelial cell density and presence of concomitant ocular conditions.

Keywords: IOL dislocation; transscleral suture fixation; implantation of iris-claw IOL.

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Влияние различных способов хирургической коррекции дислокаций интраокулярных линз на состояние эндотелия роговицы

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Введение. Дислокации интраокулярных линз (ИОЛ) — редкое, но достаточно серьёзное осложнение хирургического лечения пациентов с катарактой. Среди факторов, способствующих их развитию, основными считаются псевдоэксфолиативный синдром (ПЭС), осевая миопия высокой степени, хронические увеиты, наличие травмы в анамнезе, а также возраст. Универсальной методики коррекции дислокаций ИОЛ нет.

Цель — оценить влияние двух различных методик хирургической коррекции дислокаций ИОЛ: репозиции ИОЛ с транссклеральной шовной фиксацией и замены ИОЛ с имплантацией ирис-клоу-ИОЛ на состояние эндотелия роговицы.

Материалы и методы. В рамках исследования были обследованы и прооперированы 78 пациентов. Все пациенты были разделены на 2 группы: в первой группе была выполнена репозиция ИОЛ с транссклеральной шовной фиксацией, во второй группе — замена ИОЛ с имплантацией ирис-клоу-ИОЛ. Группы были равноценны по полу и возрасту. Основные оценочные показатели — плотность клеток эндотелия и коэффициент вариации, отражающий степень полимегатизма.

Результаты. Количество эндотелиальных клеток было достоверно ниже, как до операции, так и все сроки после операции в группе с заменой ИОЛ. Коэффициент вариации был выше в группе с заменой ИОЛ на всём протяжении данного исследования. Процент потери эндотелиальных клеток был достоверно выше в группе с заменой ИОЛ.

Выводы. Выбор методики лечения дислокации ИОЛ лежит в основе успеха хирургической коррекции и должен в обязательном порядке учитывать данные предоперационного осмотра, а именно: степень дислокации, модель ИОЛ, уровень внутриглазного давления, количество эндотелиальных клеток, а также наличие сопутствующей глазной патологии.

Ключевые слова: дислокация ИОЛ; транссклеральная шовная фиксация; имплантация ирис-клоу-ИОЛ.

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BACKGROUND

Intraocular lens (IOL) dislocation is a rare but serious complication of surgical treatment of patients with cataract. Based on literature, the prevalence of IOL dislocations varies from 0.2 to 3% [1–9]. Like this, according to one of the studies, the prevalence of IOL dislocations increases proportional to the number of years after cataract surgery and after 5 years amounts to 0.1%, after 10 years – 0.1% as well, after 15 years – 0.2%, after 20 years – 0.7%, and after 25 years – 1.7% [9]. At first glance, the prevalence of IOL dislocations is not so great. But taking into account that the life span of patients increases, same as the number of people with pseudophakia, we can expect an increase in prevalence of this kind of complications [10–12], in particular in the North-West region, where the prevalence of pseudoexfoliation syndrome (PES) is relatively high [1, 2]. It is known that PES is one of the main risk factors for IOL dislocation development, together with high axial myopia [1, 2, 13–15]. Other predisposing risk factors may include history of trauma, vitreoretinal surgery, chronic uveitis, as well as some inherited conditions (Marfan syndrome Weill–Marchesani syndrome, Ehlers–Danlos syndrome, anterior segment coloboma, etc.) [1, 2, 13–15].

IOL dislocations at the early post-op period occur in a large majority of cases outside of the capsular bag. Leading causes are intraoperative complications, as well as different options of asymmetric IOL fixation. IOL dislocations inside the capsular bag are observed predominantly in the late post-op period due to the laxity of the lens ligamentous apparatus and/or lens capsular changes [4, 14–16, 20].

The problem of most optimal method of surgical correction of late intraocular lens dislocations still remains open. Two principally different approaches are distinguished: IOL exchange and IOL repositioning with suture transscleral fixation or iris fixation [4, 15–19, 20].

The main objective of present investigation is to evaluate the influence on corneal endothelium of surgical correction of late IOL dislocations by two methods: IOL repositioning with transscleral suture fixation or IOL exchange to iris-claw one.

MATERIALS AND METHODS

From October 2018 through April 2020, 78 patients (78 eyes) were admitted to the microsurgery department No. 5 of the City multifield hospital No. 2, St. Petersburg, for surgical correction of different degree late intraocular lens dislocations. They were examined, and surgeries were performed. As exclusion criteria, we chose IOL luxation into the vitreous and different iris conditions (when implantation of iris-claw IOL was planned). All patients were divided into 2 groups: in the first group (38 patients, 38 eyes), an IOL repositioning with transscleral suture fixation was performed; in the second group (40 patients, 40 eyes) – IOL exchange to iris-claw one. Both groups were similar by patients' sex and age (Table 1).

There is no unified classification of IOL dislocation degree. In the framework of our study, we used the classification proposed by N.P. Pashtaev (1986) [19]. Into the investigation, patients with IOL dislocation degrees 2 and 3 were included.

Below, there is a description of methods used for IOL dislocation correction in the scope of the study. It is to be noted that IOL transscleral suture fixation was performed according to original method with limbal mini-pockets dissection, which was proposed by authors (patent No. 2698174 dated August 22, 2019)[20].

Description of IOL reposition with its transscleral suture fixation with limbal mini-pockets dissection (patent No. 2698174 dated August 22, 2019)

The procedure starts with application of a traction suture onto the superior rectus muscle. Next step is a formation of two triangular pockets on the level of middle limbal layers (Fig. 1). To accomplish this, in the transparent part of the limbus on 3 and 9 h or in other opposite meridians, the surgeon using a keratome makes a half-deepness about 2 mm width notch, and then a stich on the level of middle limbal layers into the direction of sclera, embedding the keratome 1.5 mm into the opaque part of the limbus [20].

Table 1. Distribution by sex and age
Таблица 1. Распределение пациентов по полу и возрасту

Indices		Main group (n = 38)	Control group (n = 40)	Confidence of difference, p
Age		78.8 ± 9.07	83.3 ± 5.29	0.17
Sex	Men	18 (47.4 %)	24 (60 %)	0.147
	Women	20 (52.6 %)	16 (40 %)	

Note. n – number of patients.

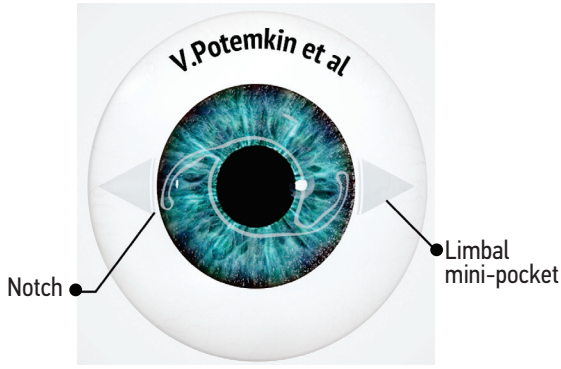


Fig. 1. Formation of limbal mini-pockets
Рис. 1. Формирование лимбальных мини-карманов

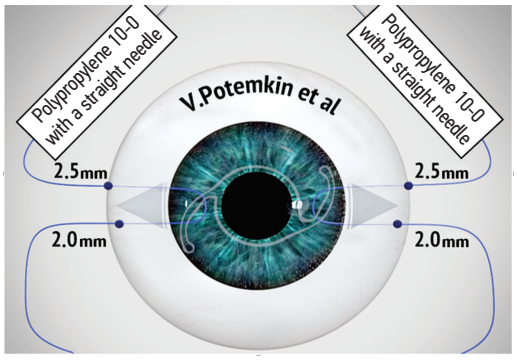


Fig. 2. IOL fixation to the sclera
Рис. 2. Фиксация интраокулярной линзы к склере

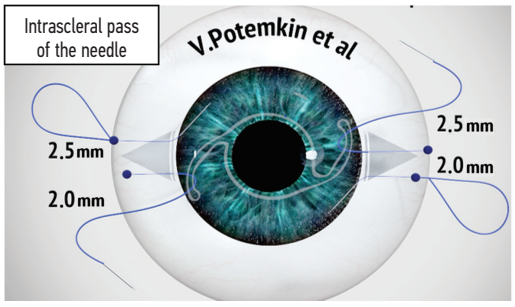


Fig. 3. Intrascleral pass of the needle
Рис. 3. Интрасклеральное проведение иглы

The IOL fixation follows: in 2–2.5 from the limbus, in the meridian of the pocket's position, the surgeon makes a stitch with a 27G injection needle; leads the needle under the IOL's haptic element; through the opposite paracentesis, inserts into it a straight needle with polypropylene 10–0 suture; and brings both of them outside. Further on, in 2–2.5 mm from the limbus and in 1 mm from the first stitch, the surgeon makes a repeated stitch with a 27G injection needle, which he leads above the IOL's haptic element; inserts into it a second straight needle with polypropylene 10–0 suture; and brings both of them outside (Fig. 2). As the result, on the haptic element, a loop out of polypropylene 10–0 suture is formed, fixing it to sclera [20].

Then the surgeon passes both needles intrasclerally into the limbal pocket's direction, and brings them outside through it [20] (Fig. 3).

The next step is the tying of sutures together with a surgical knot after preliminary cutting off of needles. The surgeon performs similar actions on the opposite meridian as well. The final step is a bi-manual irrigation-aspiration of residual viscoelastic [20].

Description of IOL exchange to iris-claw IOL

As the first step, the surgeon puts a traction suture on the superior rectus muscle. Then he separates the conjunctiva from the limbus in the upper part and forms a sclerocorneal tunnel 6 × 3 mm. Under viscoelastic cover, he explants the dislocated IOL, implants the iris-claw IOL placing it behind the pupil, and fixes it to the iris. He puts 1 suture on the tunnel (Silk 8/0). The conjunctiva is fixed to the limbus with two interrupted sutures (Silk 8/0). The final step is bi-manual irrigation-aspiration of residual viscoelastics.

In all patients, endothelial microscopy was performed using the Topcon SP3000P device (CellCount™, Japan) before surgery, as well as in 1 week, 1, 3, 6 months, and 1 year. Endothelial cell count was performed using the method of fixed frame and freehand cell selection (no less than 30) for automatic analysis [2]. The main factors to evaluate the state of corneal endothelium were endothelial cell density (number of cells per 1 mm^2), as well as the coefficient of variation (CV). The latter reflects the degree of polymegatism. The CV value (%) from 22 to 32 is considered to be normal, from 32 to 40 – elevated, and more than 40 – pathological [2, 17]. Besides, in all patients, visual acuity and IOP level were tested before surgery, as well as in 1 week, 1, 3, 6 months, and 1 year after it.

The statistical data analysis was performed using the SPSS Statistics v. 20.0 program. Kolmogorov–Smirnov test was used to check the normality of data distribution. The ratio of quantitative variables in two independent groups was evaluated using the *t*-test, that of qualitative ones –using contingency tables. At $p < 0.05$, differences were considered to be statistically significant.

RESULTS

Visual acuity with correction was estimated before surgery, in 1 week, 1, 3, 6 months, as well as in 1 year after the procedure. Before surgery, intraocular pressure indices were practically identical in groups, while in 1 week after surgery, there was a honestly significant increase of its level in the group, in which IOL exchange to iris-claw IOL was performed. Nevertheless, at all other terms, intraocular pressure indices did not differ significantly in groups ($p > 0.05$) (Table 3).

Besides, the endothelial cell density was estimated before surgery, as well as in 1 week, 1, 3, 6 months, and 1 year after it. It is worth noting, that the cell number in the group with IOL exchange was significantly lower

Table 2. Visual acuity with correction in groups

Таблица 2. Острота зрения с коррекцией в группах

Visual acuity with correction	First group (*n* = 38)	Second group (*n* = 40)	*p*
Before surgery	0.24 ± 0.28	0.28 ± 0.24	0.68
In 1 week	0.46 ± 0.36	0.48 ± 0.35	0.89
In 1 month	0.46 ± 0.35	0.63 ± 0.26	0.2
In 3 months	0.49 ± 0.35	0.58 ± 0.33	0.51
In 6 months	0.5 ± 0.34	0.56 ± 0.36	0.7
In 1 year	0.5 ± 0.34	0.6 ± 0.35	0.62

Note. *n* – number of eyes.

Table 3. Intraocular pressure level in groups

Таблица 3. Уровень внутриглазного давления в группах

Intraocular pressure level, mm Hg	First group (*n* = 38)	Second group (*n* = 40)	*p*
Before surgery	20.1 ± 4	20.3 ± 3.9	0.9
In 1 week	19.7 ± 3.6	23.5 ± 3.3	0.01
In 1 month	20.6 ± 6	19.4 ± 3.1	0.57
In 3 months	18.7 ± 2.6	18.7 ± 2.4	0.97
In 6 months	18.2 ± 3.34	19.1 ± 2.38	0.46
In 1 year	18 ± 2.8	17.8 ± 2.62	0.85

Note. *n* – number of eyes.

Table 4. Endothelial cell density in groups

Таблица 4. Плотность клеток эндотелия в группах

Endothelial cell density, cell/mm^2	First group (*n* = 38)	Second group (*n* = 40)	*p*
Before surgery	2135 ± 705	1564 ± 639	0.042
In 1 month	1896 ± 712	1300 ± 473	0.024
In 3 months	1863 ± 734	1282 ± 493	0.026
In 6 months	1844 ± 675	1264 ± 557	0.019
In 1 year	1822 ± 678	1244 ± 577	0.018

Note. *n* – number of patients.

both before surgery and during all the follow-up period ($p > 0.05$) (Table. 4, Fig. 4).

The percent of endothelial cell loss was calculated relatively to the endothelial cell level before surgery. This index was higher in patients of the IOL exchange group along the entire follow-up duration ($p < 0.05$) (Table 5).

We evaluated the variation coefficient before surgery, as well as in 1 week, 1, 3, 6 months, and in 1 year. This index was from the beginning, higher in the group with the IOL exchange, pointing out to the higher degree of epithelial polymegatism in patients of this group. During the follow-up period, the variation coefficient remained constantly higher in the IOL exchange group, but the difference was not statistically significant ($p > 0.05$).

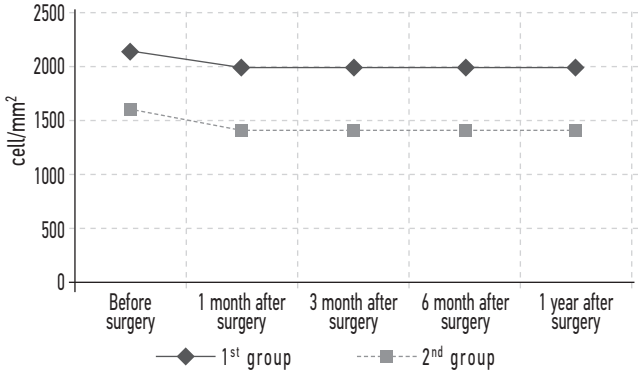


Fig. 4. Endothelial cell density in groups within 1 year

Рис. 4. Плотность эндотелиальных клеток в течение 1 года в группах

Table 5. Endothelial cell loss percentage in groups
Таблица 5. Процент потери клеток эндотелия в группах

Endothelial cell loss percentage	First group (*n* = 38)	Second group (*n* = 40)	*p*
In 1 month	11.2%	16.9%	<0.001
In 3 months	12.7%	18.0%	<0.001
In 6 months	13.6%	19.2%	<0.001
In 1 year	14.7%	20.4%	<0.001

Note. *n* – number of patients.

Table 6. Coefficient of variation in groups
Таблица 6. Коэффициент вариации группах

Coefficient of variation, %	First group (*n* = 38)	Second group (*n* = 40)	*p*
Before surgery	22.8 ± 5.2	27.5 ± 10.7	0.12
In 1 month	19.9 ± 5.2	24 ± 11.3	0.19
In 3 months	19.9 ± 6.0	25.3 ± 10.7	0.09
In 6 months	20.3 ± 6.5	26.3 ± 12.1	0.09
In 1 year	22.3 ± 8.9	27.2 ± 13.3	0.24

Note. *n* – number of eyes.

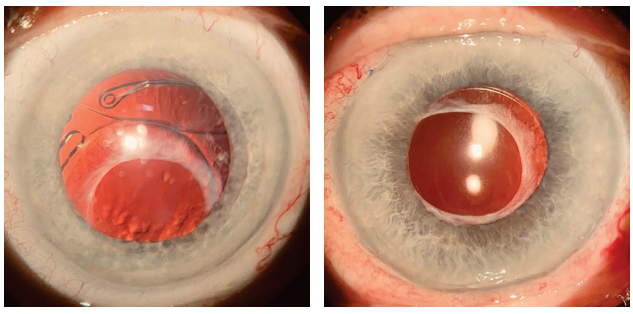
It is worth noting, that in both groups the variation coefficient stayed within normal range during all the study period (табл. 6).

Fig. 5 represents an example of patient's cornea biomicroscopy before and 3 months after surgery.

DISCUSSION AND CONCLUSIONS

IOL dislocation is a rare but sufficiently serious complication of surgical treatment of patients with cataract [1, 20]. Besides the fact that in some cases it is a cause of significant visual acuity decrease, it also may contribute to secondary glaucoma development, damage to the corneal endothelial layer, and vitreoretinopathy in the case of the IOL dislocation into the vitreous.

Within the framework of the present study, we investigated surgical treatment results of 78 patients (78 eyes)



a *b*

Fig. 5. Biomicroscopy of the patient's cornea before (*a*) and 3 months (*b*) after surgery
Рис. 5. Биомикроскопия роговицы пациента до (*a*) и через 3 месяца (*b*) после операции

with IOL dislocations. In both groups, regardless of the chosen correction method, a good postoperative result was obtained. In all patients, a correct IOL position was accomplished, which remained stable during all the follow-up period. Visual acuity increase was obtained in both groups. In the IOL reposition group, in 1 week, the percentage of patients with corrected visual acuity ≥0.4 amounted to 52.6% (20 patients, 20 eyes), in the IOL exchange group – to 40% (16 patients, 16 eyes). In 3 months, in the IOL reposition group, the percentage amounted to 57.9% (22 patients, 22 eyes), in the IOL exchange group – to 80% (32 patients, 32 eyes), in 1 year, in the IOL reposition group – to 63% (24 patients, 24 eyes), in the IOL exchange group – to 80% (32 patients, 32 eyes). The absence of visual acuity amelioration was found in 15.8% of patients (6 patients, 6 eyes) with IOL reposition and in 10% of patients with IOL exchange (4 patients, 4 eyes). Thus, both methods allow obtaining a significant visual acuity increase.

Significant visual acuity amelioration was also established in some publications. Like this, mean corrected visual acuity in one of the recent studies was higher than 0.6, while in the majority, it was not higher than 0.3–0.4 [7, 8, 18–20].

Mean IOP level did not differ in groups before surgery. But in the early post-op period (in 1 week after surgery) a significant increase of it was established in patients, in whom IOL exchange was performed. In such a way, IOP rise ≥25 mm Hg in 1 week after surgery took place in 15.8% of patients (6 patients, 6 eyes) with IOL reposition and in 40% of patients (16 patients, 16 eyes) with IOL exchange. In the rest of follow-up terms, IOP level did

not differ reliably in groups. It is worth pointing out that in the IOL exchange group, the risk increases of the fluid return flow syndrome, as well as that of the development of the hemorrhage into the suprachoroidal space. Data obtained in different studies concerning the dynamics of IOP changes during the post-op period are diverse [19–22]. It is possible that this is related to concomitant glaucoma or to presence of uveitis-glaucoma-hyphema syndrome in some patients before surgery.

The IOL exchange to the iris-claw IOL contributes to more significant endothelial cell loss [4]. Probably this is related to larger incision, surgical manipulations in the anterior chamber near to the corneal endothelium during IOL explantation, as well as post-op inflammation because of manipulations with iris. Like this, authors of one of the studies observed a reliably more prevalent post-op inflammation and larger endothelial cell loss in patients with fixation of dislocated IOL to the iris in comparison to scleral fixation [21]. In our study, the endothelial cell number both before surgery and at all periods after it was reliably lower in the group with IOL exchange. Endothelial cell loss in the group with IOL exchange was also reliably higher all through the follow-up. It is known that endothelial cells are able to compensate the loss thanks to changes in cell dimension and form [2]. Like this the coefficient of variation reflecting the polymegatism degree through all the follow-up was higher in patients with IOL exchange.

In conclusion, it may be said that looking for possible variants of IOL dislocation one has to definitely rely on its degree, clinical features, IOL model, endothelial cell number, presence of concomitant ocular diseases, as well as the surgeon's preferences. It is worth remembering that a correct choice of proper method of IOL dislocation correction is the first step on the way of its successful surgical correction.

ADDITIONAL INFORMATION

Conflict of interests. The authors declare the absence of obvious and potential conflicts of interests related to the publication of the present article.

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