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Method of intraocular lens fixation in patients with compensated glaucoma and cataract complicated by zonular weakness

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ABSTRACT

BACKGROUND: The combination of cataract and glaucoma occurs in 14.6–76% of cases, and zonular weakness — in 34%. By suturing the lens in the posterior chamber, ophthalmic surgeons create a more physiological position for it.

AIM: The aim of this study is to evaluate the clinical efficacy of intraocular lens fixation in patients with compensated glaucoma and cataract complicated by zonular weakness.

MATERIALS AND METHODS: 49 patients with compensated glaucoma and cataract complicated by zonular weakness were operated. Uncorrected visual acuity — 0.19, best corrected visual acuity — 0.25, tonometric intraocular pressure — 18.9 mm Hg. Operation technique: a corneal tunnel is formed at 9 o'clock, 4 iris-retractors are inserted through paracenteses at 2, 5, 8, 11 hours and fixed at the edge of the capsulorhexis. After lens extraction, 2 iris-retractors (at 5, 11 hours) are removed . The lens is implanted into the anterior chamber. Haptic elements are tucked under the iris in the projection of 5 and 11 hours, the optical part is transferred to the posterior chamber. The support elements are sutured with interrupted sutures to the iris, then 2 iris-retractors are removed (at 2 and 8 hours), the capsular bag is removed using tweezers, and the paracenteses and the tunnel are hydrated.

RESULTS: On the first day, the best corrected visual acuity was 0.34, by the 5th day, it increased to 0.49 ± 0.08, by the 14th day — 0.52. As the glaucoma process progressed during 2 years after surgery, best corrected visual acuity decreased to 0.47, intraocular pressure was 18.4 mm Hg.

CONCLUSIONS: An original and easy to perform suture fixation of the lens to the iris is proposed, which allows to reduce the risk of lens decentration and tilt, as well as that of vitreous herniation.

Keywords: glaucoma; cataract; phacoemulsification; trabeculectomy; intraocular lens; intraocular pressure; lens subluxation.

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Метод фиксации интраокулярной линзы у пациентов с компенсированной глаукомой и катарактой, осложнённой слабостью связочного аппарата

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АННОТАЦИЯ

Актуальность. Сочетание катаракты и глаукомы встречается в 14,6–76 % случаев, а нарушение связочного аппарата хрусталика — в 34 %. Подшивая линзу в задней камере, офтальмохирурги создают более физиологичное её расположение.

Цель — оценить клиническую эффективность фиксации линзы у пациентов с компенсированной глаукомой и катарактой, осложнённой нарушением связочного аппарата хрусталика.

Материалы и методы. Оперировано 49 пациентов с компенсированной глаукомой и катарактой, осложнённой слабостью связочного аппарата хрусталика. Некорригируемая острота зрения — 0,19, максимальная корригируемая острота зрения — 0,25, тонометрическое внутриглазное давление — 18,9 мм рт. ст. Техника операции: формируется роговичный тоннель на 9 ч условного циферблата, через парацентезы на 2, 5, 8, 11 ч фиксируются 4 ирис-ретрактора за край капсулорексиса. После экстракции хрусталика удаляются 2 ирис-ретрактора — на 5, 11 ч. Линзу имплантируют в переднюю камеру. Затем гаптические элементы заправляют под радужку в проекции 5 и 11 ч, а оптическую часть переводят в заднюю камеру. Опорные элементы подшивают узловыми швами к радужке, после чего снимают ирис-ретракторы, размещенные на 2 и 8 ч, пинцетом удаляет капсульный мешок, производят гидратацию парацентезов и тоннеля.

Результаты. На первые сутки максимальная корригируемая острота зрения составила 0,34, к 5-у дню увеличилась до 0,49 ± 0,08, к 14-му дню — 0,52. По мере прогрессирования глаукомного процесса в течение 2 лет после операции она снизилась до 0,47, внутриглазное давление — 18,4 мм рт. ст.

Выводы. Предложена оригинальная и простая в исполнении методика шовной фиксации линзы к радужке, позволяющая снизить риск децентрации и наклона линзы, а также грыжи стекловидного тела.

Ключевые слова: глаукома; катаракта; факоэмульсификация; синустрабекулэктомия; интраокулярная линза; внутриглазное давление; подвывих хрусталика.

Как цитировать

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BACKGROUND

Currently, phacoemulsification with intraocular lens (IOL) implantation is a standard of cataract surgery. Correct intracapsular lens positioning is ensured by the suspensory ligament of the lens attached to the capsular bag. Concomitant eye diseases (glaucoma, pseudoexfoliation syndrome, high myopia, etc.) affect the lens zonules, which increases the risk of intraoperative complications and postoperative IOL decentration and dislocation [1, 2].

A combination of cataract and glaucoma is observed in 14.6%–76% of cases, and zonular disorders are detected in 34% of these patients [3–6]. In patients with significant zonular loss, cataract extraction also includes capsular bag removal, followed by IOL suture fixation or implantation of an anterior chamber lens.

Positioning IOL in the posterior chamber is more natural, so many ophthalmic surgeons prefer transscleral suture fixation of the IOL to the episclera or iris [7–9]. The main requirements for suture fixation are long-term, safe, and effective lens positioning, resulting in maximum visual acuity and minimal risk of complications.

IOL suture fixation, especially with S-loop haptics, to the iris is one of the most popular techniques. Currently, there are techniques for suturing IOLs to the iris that are focused on preventing lens dislocation into the vitreous cavity during implantation and postoperative displacement [10–12]. Temporary fixation of the lens during suturing to the iris is essential to prevent intraoperative IOL dislocation and decentration. Given the high risk of IOL displacement, especially with S-loop haptics, into the vitreous cavity during suturing, we have proposed a technique for temporary lens fixation. This technique involves using iris retractors, which retain and stabilize the capsule bag during phacoemulsification.

The *study aimed* to evaluate the clinical effectiveness of the proposed technique of posterior chamber IOL fixation in patients with compensated glaucoma and cataract complicated by a zonular disorder.

MATERIALS AND METHODS

The study included 49 patients with compensated glaucoma and cataract complicated by zonular weakness; 31 (63.3%) patients were men, and 18 (36.7%) were women. The age of patients ranged from 59 to 78 years. The duration of glaucoma was 5 months to 9 years. All patients had grade 2–3 lens subluxation according to the Pashtaev lens dislocation classification (1986). A total of 15 (30.6%) and 34 (69.4%) patients had moderate and advanced glaucoma, respectively. Uncorrected visual acuity was 0.19 ± 0.08, best corrected visual acuity (BCVA) was 0.25 ± 0.1, and intraocular pressure (IOP) was 18.9 ± 0.9 mmHg (see Table 1).

Pre-operative examination in all patients included visometry, biomicroscopy, gonioscopy, ophthalmoscopy, perimetry, Maklakov tonometry, pachymetry, ophthalmometry, and B-scan ultrasound.

Surgery technique (patent No. 2808195 dated November 24, 2023). A corneal tunnel is created per a standard procedure at 9 o'clock, then paracenteses are formed at 2, 5, 8, and 11 o'clock. Four iris retractors are hooked by the capsulorhexis edge, thereby fixing a lens-iris diaphragm. After lens phacoemulsification (Fig. 1), two opposite iris retractors are removed (at 5 and 11 o'clock). The anterior capsule flap between the iris retractors at 2 and 8 o'clock (Fig. 2) is a diaphragm separating the posterior chamber from the vitreous cavity. Then the IOL is implanted into the anterior chamber filled with a viscoelastic. The IOL haptics are inserted under the iris at 5 and 11 o'clock, and the optical part is moved to the posterior chamber (Fig. 3). This allows stabilizing the IOL in the posterior chamber without using instruments. Then the stabilizing arms are fixed with two interrupted sutures to the iris, the iris retractors at 2 and 8 o'clock are removed, the capsular bag is removed with forceps (Fig. 4), and the paracenteses and tunnel are hydrated.

RayOne Aspheric IOL with two haptics (Rayner, UK) was implanted in 21 patients, and Akreos Adapt AO (Bausch&Lomb, USA) with four haptics was implanted in 28 patients.

Statistical data processing was performed using Statistica v. 10. In this study, the variables were normally distributed, so they were presented as $M \pm \sigma$.

RESULTS AND DISCUSSION

There were no significant intraoperative complications (expulsive hemorrhage, lens dislocation, or ocular hypertension). An unplanned narrow capsulorhexis of 4 mm was created in 3 cases because of decreased stretching of the anterior capsule and lens mobility. This challenged the phacoemulsification stages. During iris retractor placement, hemorrhages of the pupillary margin were noted at the iris retractor stretching site in 4 eyes with a narrow pupil; the next day the hemorrhages appeared as hyphema or blood clots on the pupillary margin. By day 5, the hemorrhages completely resolved without special treatment.

Significant zonular weakness led to intraoperative wrinkling and capsular bag folds after lens removal. Capsular bag preservation leads to a high risk of capsule contraction syndrome and postoperative capsular fibrosis, which require additional surgical procedures. Therefore, there was no need to preserve the capsular bag with extensive zonular damage, so the capsule was completely removed after IOL suturing.

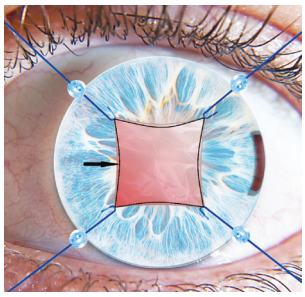

Fig. 1. After lensectomy, at 2, 5, 8 and 11 hours, 4 iris-retractors are fixed at the edge of the capsulorhexis. The arrow indicates the tension of the capsulorhexis margin
Рис. 1. После ленсэктомии на 2, 5, 8 и 11 ч фиксируют 4 ирис-ретрактора за край капсулорексиса. Стрелкой указано натяжение края капсулорексиса

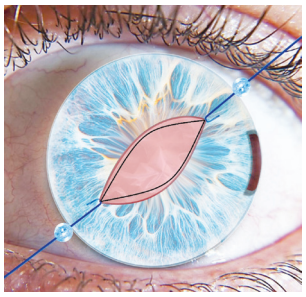

Fig. 2. Anterior capsule stretched between iris-retractors at 2 and 8 hours
Рис. 2. Передний листок капсулы натянут между ирис-ретракторами на 2 и 8 ч

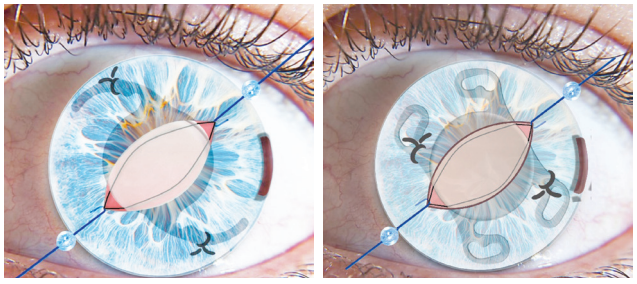

Fig. 3. Intraocular lens behind the iris, the optical part is located on the stretched capsular bag, haptic elements are sutured to the iris with interrupted sutures
Рис. 3. Интраокулярная линза за радужкой, оптическая часть располагается на растянутом капсульном мешке, гаптические элементы подшиты к радужке узловыми швами

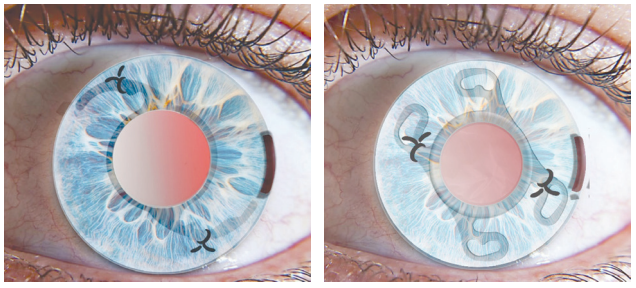

Fig. 4. The intraocular lens is located behind the iris, and its haptic elements are sutured with interrupted sutures to the iris
Рис. 4. Интраокулярная линза расположена за радужкой и подшита узловыми швами за гаптические элементы к радужке

On postoperative day 1, Descemet membrane folds were reported in 24 (49%) cases (see Table 1). After 5 days, antibiotic, glucocorticoid, and non-steroidal anti-inflammatory drug therapy decreased the proportion of eyes with Descemet membrane folds to 18.4% (n = 9), and by day 14, negligible folds were observed only in 1 (2%) eye.

On postoperative day 1, fibrinous exudate with Descemet membrane folds occurred in the pupillary area in 5 (10.2%) eyes. These patients additionally received subconjunctival recombinant prourokinase 5000 IU for 4 days; the treatment led to resolution of fibrinous exudate in 4 patients. The treatment was continued for 3 days in one patient until fibrinous exudate resolved completely.

Corneal edema associated with hypertension on day 1 after phacoemulsification was observed in 7 (14.3%) patients. As these patients used hypotensive drugs for glaucoma, they were prescribed the most aggressive hypotensive regimen, which normalized IOP by day 5 in 6 cases and by day 10 in one patient.

Because of complications reducing the transparency of the ocular media (Descemet membrane folds, corneal edema, hyphema, fibrinous exudate), BCVA on day 1 was 0.34 ± 0.04. Visual acuity increased to 0.49 ± 0.08 by day 5 and to 0.52 ± 0.05 by day 14. Two years after surgery, BCVA was 0.47 ± 0.06, and IOP was 18.4 ± 0.9 mmHg. There were no cases of IOL subluxation, and the sutures were intact in all cases (Fig. 5). Optical coherence tomography of the sutured lens showed its correct position without iris deformation (Fig. 6). Notably, target IOP (considering the glaucoma stage and pachymetry data) was maintained in all patients throughout the follow-up period, and it required trabeculectomy in 8 (16.3%) cases.

The proposed method has the following advantages:

1) The iris retractors used to stabilize the lens provide dilation during IOL suturing;

2) The created diaphragm of the stretched lens capsule between two iris retractors is a stable support for the lens located behind the iris;

3) Placing the IOL on a temporary capsule diaphragm allows centering and suturing the IOL haptics to the iris;

4) After suturing the stabilizing arms, the iris retractors and capsular bag are removed from under the lens, leaving it centered behind the iris;

5) The capsular bag prevents vitreous prolapse into the pupil and the formation of vitreous hernia during IOL suturing.

Other authors reported that fixation of the IOL haptics to the iris provides a stable central location of the lens, which leads to high visual outcomes (BCVA 0.7 ± 0.4) over a long-term follow-up period [13]. Hemorrhages in the anterior chamber were detected in 30.7% of cases in the early postoperative period. In the long-term postoperative period, an irregular, oval, and rounded pupil was reported in 9.7%, 14.5%, and 75.8% of cases, respectively. Signs of atrophy of the pigmented iris edge were also detected in 12.9% of cases.

Parker and Price analyzed hemorrhagic complications of lens suturing to the iris in patients receiving indirect anticoagulants [14]. Hyphema was reported only in 1 of 7 patients 6 weeks after surgery; it resolved completely

Table. Pre- and postoperative state of patients with phacoemulsification and intraocular lens suturing (*n* = 49)

Таблица. До- и послеоперационное состояние пациентов с факоэмульсификацией и подшиванием интраокулярной линзы (*n* = 49)

Parameter		Value
Preoperatively		
Moderate glaucoma, *n*		15 (30.6%)
Advanced glaucoma, *n*		34 (69.4%)
LOCS III, *n*	NC1-3	19 (38.8%)
	NC4-5	30 (61.2%)
UCVA, *M* ± σ		0.19 ± 0.08
BCVA, *M* ± σ		0.25 ± 0.1
IOP, mmHg, *M* ± σ		18.9 ± 0.9
Postoperative day 1		
UCVA, *M* ± σ		0.31 ± 0.05*
BCVA, *M* ± σ		0.34 ± 0.04*
Complications, *n*	descemet membrane folds	24 (49%)
	fibrinous exudate	5 (10.2%)
	ocular hypertension	7 (14.3%)
	hyphema	4 (8.2%)
Postoperative day 5		
UCVA, *M* ± σ		0.43 ± 0.07*
BCVA, *M* ± σ		0.49 ± 0.08*
Complications, *n*	descemet membrane folds	9 (18.4%)
	fibrinous exudate	1 (2%)
	ocular hypertension	1 (2%)
Postoperative day 14		
UCVA, *M* ± σ		0.48 ± 0.06*
BCVA, *M* ± σ		0.52 ± 0.05*
Complications, *n*	descemet membrane folds	1 (2%)
	fibrinous exudate	0
	ocular hypertension	0
	hyphema	0
6 months postoperatively		
UCVA, *M* ± σ		0.44 ± 0.09*
BCVA, *M* ± σ		0.50 ± 0.07*
IOP, mmHg, *M* ± σ		18.7 ± 0.8
Trabeculectomy, *n*		1 (2%)
1 year postoperatively		
UCVA, *M* ± σ		0.43 ± 0.07*
BCVA, *M* ± σ		0.48 ± 0.04*
IOP, mmHg, *M* ± σ		18.5 ± 1.0
Trabeculectomy, *n*		4 (8.2%)
2 years postoperatively		
UCVA, *M* ± σ		0.41 ± 0.06*
BCVA, *M* ± σ		0.47 ± 0.06*
IOP, mmHg, *M* ± σ		18.4 ± 0.9
Trabeculectomy, *n*		8 (16.3%)

Note. UCVA — un-correction visual acuity, BCVA — best corrected visual acuity, IOP — intraocular pressure (mm Hg), *$p < 0.05$ compared to preoperative UCVA and BCVA.

Примечание. UCVA — некорригируемая острота зрения, BCVA — максимальная корригируемая острота зрения, IOP — внутриглазное давление. *$p < 0,05$ в сравнении с дооперационными показателями.

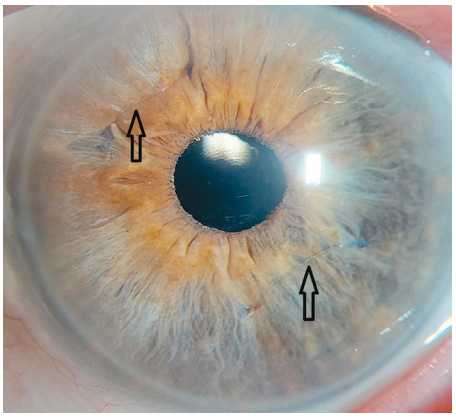

Fig. 5. State of the anterior segment of the eye 2 years after cataract extraction and suturing of the intraocular lens to the iris according to the proposed method. The arrows indicate polypropylene 10/0 sutures fixing the lens
Рис. 5. Состояние переднего отрезка глаза через 2 года после экстракции катаракты и подшивания интраокулярной линзы к радужке по предложенной методике. Стрелками указаны фиксирующие линзу швы полипропиленом 10/0

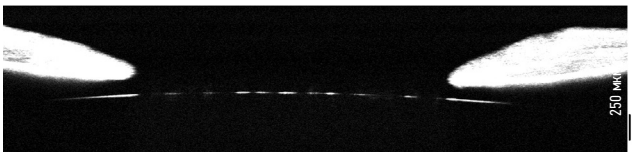

Fig. 6. On optical coherence tomogram, a correct position of the sutured intraocular lens
Рис. 6. На оптической когерентной томограмме правильное расположение подшитой интраокулярной линзы

within a week. The authors noted the safety and effectiveness of this method for IOL fixation in such patients.

Ultrasound of the lenses sutured to the iris proved no lens displacement and tilt in the posterior chamber [15]. No signs of chronic inflammation manifesting as anterior and posterior synechiae were observed. However, the iris structure at the iris-haptic suture was changed in all patients.

Thus, the proposed technique of IOL fixation during its suturing to the iris is safe for cataract surgery in patients with a zonular defect and compensated glaucoma.

CONCLUSION

The developed method of iris suture fixation of the IOL reduces the risk of vitreous hernia into the pupil and lens decentration and dislocation.

The proposed technique is not a risk factor for increased IOP in the early postoperative period and does not require additional glaucoma procedures in patients with compensated glaucoma and cataract complicated by zonular damage.

The developed method of iris fixation of the lens is effective and safe and may find extensive application in cataract surgery in patients with zonular damage and compensated glaucoma.

ADDITIONAL INFO

Authors' contribution. All authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study. Personal contribution of each author: E.A. Ivachev — collecting and preparation of samples, writing the main part of the text; S.A. Kochergin — experimental design, data analysis, making final edits; O.T. Ivacheva — collecting and preparation of samples; writing the main part of the text, literature review.

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Competing interests. The authors declare that they have no competing interests.

Consent for publication. Written consent was obtained from the patients for publication of relevant medical information within the manuscript.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Вклад авторов. Все авторы внесли существенный вклад в разработку концепции, проведение исследования и подготовку статьи, прочли и одобрили финальную версию перед публикацией. Личный вклад каждого автора: Е.А. Ивачёв — сбор и обработка материалов, написание текста; С.А. Кочергин — концепция и дизайн исследования, анализ полученных данных, внесение окончательной правки; О.Т. Ивачёва — сбор и обработка материалов, написание текста, обзор литературы.

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Информированное согласие на публикацию. Авторы получили письменное согласие пациентов на публикацию медицинских данных.

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