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Scientific article



Influence of the quality of viscoelastic removal on phacoemulsification results.

Part 1. Type of the postoperative period course depending on the quality of viscoelastic removal in phacoemulsification

© Anna V. Egorova, Alexey V. Vasiliev, Lina Bai

S.N. Fyodorov Eye Microsurgery Federal State Institution, Khabarovsk, Russia

BACKGROUND: The reasons for the development of postoperative reactive inflammation under optimal conditions for the operation are errors in the surgical technique and the presence of viscoelastic residues. The likelihood of developing ophthalmic hypertension exists with the use of viscoelastic of any type. Its incomplete evacuation can be explained by the difficult visualization due to its transparency. Analysis of the dependence of the postoperative period course on the quality of viscoelastic removal at phacoemulsification can be considered to be relevant and expedient.

AIM: The aim was to study the type of the postoperative period course depending on the quality of viscoelastic's removal at phacoemulsification.

MATERIALS AND METHODS: 104 eyes of randomly chosen patients who underwent femto-laser assisted phacoemulsification, divided into 2 groups according to ophthalmic viscoelastic's characteristics (colored or transparent). Both groups were split into 2 subgroups each depending on method of viscoelastic's removal. Tonometry and biomicroscopy were performed 3 hours after phacoemulsification and on the post-op Day 1. Patients with Tyndall effect were examined daily until it's disappearance.

RESULTS: At comparable preoperative IOP indices, its elevation 3 hours after surgery took place in subgroups 2a and 2b, the highest being in subgroup 2a. The greatest number of eyes with Tyndall effect, at all follow-up periods, was found in subgroup 2a, the lowest – in subgroup 1b. The total number of eyes with keratopathy (as epitheliopathy) observed 3 hours after surgery was 7, four of them being from subgroup 2a.

CONCLUSIONS: The conducted research showed that the type of early postoperative period course of phacoemulsification depends on visualization possibility of the viscoelastic and of the method of its removal. Minimal changes of hydrodynamics and maximal number of eyes with absence of inflammation took place when using colored viscoelastic and impulse – irrigation method.

Keywords: phacoemulsification; viscoelastic; hypertension; keratopathy.

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Научная статья

Влияние качества удаления вискоэластика на результаты факоемульсификации.

Часть 1. Характер течения послеоперационного периода в зависимости от качества удаления вискоэластика при факоемульсификации

© А.В. Егорова, А.В. Васильев, Л. Бай

Национальный медицинский исследовательский центр «Межотраслевой научно-технический комплекс «Микрохирургия глаза» имени академика С.Н. Фёдорова», Хабаровск, Россия

Актуальность. Причинами развития послеоперационного реактивного воспаления при наличии оптимальных условий для операции являются погрешности хирургической техники и наличие остатков вискоэластика. Вероятность развития офтальмогипертензии существует при использовании вискоэластика любого типа, неполную эвакуацию которого можно объяснить затруднённой визуализацией из-за его прозрачности. Исследование характера течения послеоперационного периода от качества удаления вискоэластика при факоемульсификации можно считать актуальным и целесообразным.

Цель — исследовать характер течения послеоперационного периода в зависимости от качества удаления вискоэластика при факоемульсификации.

Материалы и методы. Группу наблюдения составили 104 случайных пациента (104 глаза), оперированных по поводу возрастной катаракты методом факоемульсификации с фемтосекундным лазерным сопровождением и случайным образом разделённых на 2 группы в зависимости от характеристики вискоэластика (окрашенный или неокрашенный). По методу удаления вискоэластика обе группы были разделены на 2 подгруппы. Через 3 ч и в первые сутки после факоемульсификации проводили тонометрию, осуществляли биомикроскопию, у пациентов с наличием феномена Тиндаля — ежедневно до его исчезновения.

Результаты. При сопоставимых предоперационных показателях внутриглазного давления его повышение через 3 ч после операции имело место в подгруппах 2а и 2б, наибольшее — в подгруппе 2а. Наибольшее количество глаз с феноменом Тиндаля во все сроки наблюдения было выявлено в подгруппе 2а, а наименьшее — в подгруппе 1б. Суммарное количество глаз с кератопатией в виде эпителиопатии, выявленной через 3 ч после операции, составило 7 (7 %), из которых наибольшее число глаз (4, 4 %) встречалось в подгруппе 2а.

Заключение. Проведённое исследование показало, что характер течения раннего послеоперационного периода факоемульсификации зависит от возможности визуализации и способа удаления вискоэластика. Минимальные изменения гидродинамики и максимальное количество глаз с отсутствием воспалительной реакции имело место при использовании окрашенного вискоэластика и метода импульс-ирригации.

Ключевые слова: факоемульсификация; вискоэластик; гипертензия; кератопатия.

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BACKGROUND

One of the main aims of phacoemulsification (PE) is to minimize the surgical trauma through the use of microinvasive technologies for lens removal, of biologically inert consumables, and of intraocular lenses (IOLs) to ensure an areactive course postoperatively and improve the quality of medical and social rehabilitation of this category of patients [1–3]. According to the literature, deviations from the “zero” reaction (according to the classification of S.N. Fedorov and E.V. Egorova, 1992) of the operated eye are most often caused by reactive inflammation (0.05%–1.6%), corneal edema (0.5%–4.5%), and ocular hypertension (1%–2%) [4–6]. These complications in presence of optimal conditions for surgery are caused by errors in surgical technique and the presence of viscoelastic (VE) residues [7, 8].

The VEs used in cataract surgery are divided into two groups, cohesive and dispersive [9]. Considering the physicochemical properties in the preparations of both groups, undoubtedly, at the stage of VE residue removal from the eye, cohesive VE agents, unlike dispersive ones, can be evacuated to the fullest extent [7–9]. Taking into account the need for complete removal of VE residues after PE as an indisputable surgical requirement, studies have shown that the risk of ocular hypertension exists when any type of VE was used [10–13]. With the standard method of VE removal using an irrigation–aspiration system, the main factor causing incomplete evacuation of VE from the anterior and posterior chambers, as well as from the lens capsule, should obviously be recognized as difficult visualization because of its transparency [11, 12, 14]. Possibly, a more preferable method for VE removal is impulse irrigation proposed in 2004 by Takhchidi, which is based on the separation of the VE from the underlying structures of the anterior segment of the eye with a balanced saline solution and its subsequent spontaneous evacuation through the main incision [6]. In addition, stained VE could be used to solve this problem, which would help controlling its presence in the eye [15, 16].

Considering all of the above, investigating the dependence of postoperative course on the quality of VE removal in PE could be considered as relevant and appropriate.

This study aimed to evaluate the postoperative course based on the quality of VE removal in PE.

MATERIALS AND METHODS

The study group consisted of 104 random patients (104 eyes) operated on for age-related cataracts (presenile and senile according to ICD10). Patients with optimal conditions for surgery, namely, mydriasis of at least 6 mm, lens nucleus density NC 2–3 according to the LOCS III classification (1993) [17], absence of exfoliations and of signs of weakness of the lens zonular support, and of corneal pathological condition were included. The study involved 54 women and 50 men. The age of the patients ranged from 60 to 83 (mean, 73.5 ± 6.3) years.

In all eyes, PE was performed according to the standard technique. To unify its parameters, first, using a LenSx femtosecond laser (Alcon, USA), capsulorhexis with 5.0 mm diameter was performed, followed by fragmentation of the lens nucleus, and the main corneal incision (2.2 mm) was made at the 10 o'clock position, followed by two additional corneal incisions (1.1 mm) at 1 and 7 o'clock positions. Then, using the Infiniti phacoemulsifier (Alcon), the lens nucleus was fragmented and removed using the phaco-chop technique, the cortical masses were aspirated using a bimanual irrigation–aspiration system, and an IOL Hoya Isert 251 (Japan) was implanted. Finally, the main incision and corneal paracentesis were hydrated, and the anterior chamber was replenished with a balanced solution until a normal intraocular pressure (IOP) status was achieved. External filtration was absent in all cases. All surgeries were performed using a PROvido 8 operating microscope (Leica, Germany).

Before the removal of the anterior capsule leaf formed after femtocapsulorhexis, VE DisCoVisc (Alcon, USA) was injected in all cases. Depending on the characteristics of the VE used to fill the anterior chamber before IOL implantation, all eyes were randomly divided into two groups. In 54 eyes of group 1 (main), stained VE agent was used, which was prepared according to the method proposed by Polit and Polit [15] for staining the anterior capsule. For this purpose, 0.1 mL of Rhex ID trypan blue dye (Appasamy, India) was added to a syringe containing 0.55 mL of a VE solution of 1% sodium hyaluronate. The two substances were mixed by moving the syringe plunger back and forth. The stained VE agent was injected into the anterior chamber and capsular bag. Group 2 (control) consisted of 50 patients (50 eyes), in whom the anterior chamber was filled with a VE solution of 1% sodium hyaluronate before IOL implantation. The use of stained VE did not impair visualization. Staining of the endothelium of the cornea, iris, and posterior capsule was also not noted in any case.

Both groups were divided into two subgroups according to the VE removal method. In subgroups 1a (29 eyes) and 2a (26 eyes), VE agent was removed using a bimanual irrigation–aspiration system; while in subgroups 1b (25 eyes) and 2b (24 eyes), the pulse irrigation method was used [6].

After surgery, all patients received treatment with instillations of 0.3% ciprofloxacin solution four times a day for 7 days and 0.1% dexamethasone solution three times a day for 1 month.

In all cases, a standard ophthalmological examination (visual acuity testing, biometry, ophthalmometry, refractometry, biomicroscopy, and ophthalmoscopy) was performed before the surgery.

Before surgery, 3 h after PE and on Day 1 after it, Maklakov tonometry with a weight of 10.0 g was performed. Moreover, slit-lamp biomicroscopy was performed to detect keratopathy and opalescence of the anterior chamber fluid, and in patients with Tyndall phenomenon, it was performed daily before the vanishing of the phenomenon.

The study did not include patients with glaucoma, severe somatic pathology, and history of allergic reactions.

Data were statistically processed using IBM SPSS Statistics 20 program. Shapiro–Wilk test was used to test the normality of distributions. Normally distributed data are presented as $M \pm \sigma$, where M is the mean value and σ is the standard deviation. Non-normally distributed data are presented as $Me [Q_{25}; Q_{75}]$, where Me is the median, and Q_{25} and Q_{75} are the 25th and 75th quantiles, respectively. Quantitative indicators and qualitative signs were compared using the Mann–Whitney U -test and Fisher's exact test, respectively. The critical significance level was 0.05.

RESULTS

All surgeries were performed as scheduled and no intraoperative complications were noted in any of the cases. The indicators of IOP before and after PE of age-related cataract are presented in Table 1.

Data analysis presented in the table revealed that with comparable preoperative IOP values, it increased 3 h after surgery in subgroups 2a and 2b, with the largest (1.3 times) increase in subgroup 2a. This result is attributed to the increase in IOP higher than 26 mm Hg in six eyes of subgroup 2a and two eyes of subgroup 2b. On Day 1 after surgery, subgroups 2a and 2b experienced a decrease in IOP; however, the values were not similar. During the follow-up period, IOP values in subgroups 1a and 1b almost did not change.

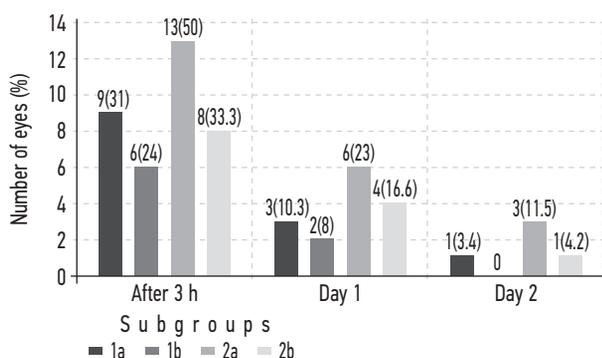


Figure. Number of eyes with Tyndall effect at different times after phacoemulsification of senile cataract

Рисунок. Количество глаз с феноменом Тиндаля в различные сроки после фактоэмульсификации возрастной катаракты

Table. IOP indices before and after phacoemulsification of senile cataract, $Me [Q_{25}; Q_{75}]$

Таблица. Показатели внутриглазного давления до и после фактоэмульсификации возрастной катаракты, $Me [Q_{25}; Q_{75}]$

Subgroup	Intraocular pressure, mm Hg		
	Before surgery	3 h after surgery	Day 1 after surgery
Subgroup 1a ($n = 29$ eyes)	20 [18; 21]	20 [18; 23]	20 [18; 22]
Subgroup 1b ($n = 25$ eyes)	19 [18; 21]	19 [18; 23]	19 [18; 21]
Subgroup 2a ($n = 26$ eyes)	19 [18; 21]	24 [21; 26]*	22 [18; 23]
Subgroup 2b ($n = 24$ eyes)	19 [18; 22]	22 [18; 23]**	21 [19; 23]

* Significant differences from subgroup 1a; ** significant differences from subgroup 1b.

Special attention should be paid to the degree of response to surgical trauma manifested as the Tyndall phenomenon in the anterior chamber fluid (Fig. 1).

The data presented in the figure show that the largest number of eyes with the Tyndall phenomenon in all follow-up periods was registered in subgroup 2a, and the smallest number was noted in the subgroup 1b. In all follow-up periods, the same number of eyes in subgroups 1a and 2b had opalescence of the intraocular fluid in the anterior chamber ($p > 0.1$).

The cornea underwent minimal changes depending on the VE used and the method of its removal after PE of age-related cataract. Seven (7%) eyes had keratopathy in the form of epitheliopathy detected 3 h after surgery, and the largest number of these eyes (4.4%) was recorded in subgroup 2a.

DISCUSSION

Insufficient attention is paid to the eye reaction to surgical trauma due to the absence of obvious signs of a negative response from the operated eye, which is considered an areactive course of the postoperative period. At compliance to all technological principles of PE and at the absence of mechanical damage to the cornea, iris, and lens capsule, VE residues are known to provoke the development of transient pathological changes in the anterior segment of the eye.

Data on the frequency of hypertension, opalescence of the anterior chamber fluid, and keratopathy do not exceed the average statistical indicators indicated in the ophthalmological literature [3, 5, 18]. Moreover, a close analysis of these complications shows the dependence of their occurrence on the quality of imaging and method of VE removal.

Thus, postoperative IOP values were significantly higher in subgroup 2a, and the minimum level was measured in subgroup 1b. This was due to the poor visualization of VE residues in the anterior chamber angle and in the posterior chamber and its subsequent spread into the drainage system of the eye, which led to a change in postoperative IOP compared with the initial one. A minimal increase in IOP after PE is achieved either by using a well-visualized (stained) VE agent or by using the impulse irrigation method.

A similar tendency can be seen in the analysis of eyes with the Tyndall phenomenon. The maximum number of eyes with the Tyndall phenomenon presenting as a single

suspension of cellular elements, and its longest presence was also registered in subgroup 2a, and the minimum one was noted in subgroup 1b ($p > 0.1$). In our opinion, with all other conditions of surgical exposure being equal, the factor that determines the presence of this condition is an increased local immune response of the intraocular structures to the presence of a VE agent.

Considering the above results, the least influence of VE residues was noted when assessing the state of the cornea. Only 2 of 7 eyes had a clinical presentation of Grade 1 diffuse hypertensive keratopathy accompanied by an increase in IOP to 30–32 mm Hg 3 h after surgery, while epitheliopathy was noted in the remaining five eyes, apparently caused by the initial signs of the dry eye syndrome.

CONCLUSIONS

1. The study revealed that the early postoperative course of PE for age-related cataract depends on the visualization and method of VE removal.

2. Minimal changes in the hydrodynamics and the maximum number of eyes with no inflammatory reaction were

noted when stained VE and the impulse irrigation method were used.

3. The presence of the Tyndall phenomenon does not depend on the VE used and is due to the individual reaction of the eye to surgical trauma.

ADDITIONAL INFORMATION

Author contributions. All authors confirm that their authorship complies with the international ICMJE criteria. All authors have made a significant contribution to the development of the concept, research, and preparation of the article, as well as read and approved the final version before its publication. A.V. Egorova collected and processed the material, performed statistical processing, and prepared the text. A.V. Vasiliev created the concept and design of the study, edited the text, and approved the manuscript for publication. Lina Bai collected and processed the material, performed statistical processing, and prepared the text.

Conflict of interest. The authors declare no conflict of interest.

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AUTHORS' INFO

***Anna V. Egorova**, Cand. Sci. (Med.), ophthalmologist;
address: 211 Tikhookeanskaya str., Khabarovsk, 680033, Russia;
ORCID: <https://orcid.org/0000-0002-7079-8359>; eLibrary SPIN:
7161-7481; Scopus: 25631622800; e-mail: naukakhvmtk@mail.ru.

Alexey V. Vasiliev, Cand. Sci. (Med.), ophthalmologist;
ORCID: <https://orcid.org/0000-0001-9712-0276>;
eLibrary SPIN: 5780-0798; e-mail: naukakhvmtk@mail.ru.

Lina Bai, ophthalmologist;
ORCID: <https://orcid.org/0000-0003-0107-643X>;
eLibrary SPIN: 2005-4948; e-mail: naukakhvmtk@mail.ru

ОБ АВТОРАХ

***Анна Викторовна Егорова**, канд. мед. наук, врач-офтальмолог;
адрес: Россия, 680033, Хабаровск, ул. Тихоокеанская, д. 211;
ORCID: <https://orcid.org/0000-0002-7079-8359>; eLibrary SPIN:
7161-7481; Scopus: 25631622800; e-mail: naukakhvmtk@mail.ru

Алексей Владимирович Васильев, канд. мед. наук, врач-офтальмолог; ORCID: <https://orcid.org/0000-0001-9712-0276>;
eLibrary SPIN: 5780-0798; e-mail: naukakhvmtk@mail.ru

Лина Бай, врач-офтальмолог;
ORCID: <https://orcid.org/0000-0003-0107-643X>;
eLibrary SPIN: 2005-4948; e-mail: naukakhvmtk@mail.ru

* Corresponding author / Автор, ответственный за переписку