SINGLE-STAGE ENDOVITREAL SURGERY OF RETINAL DETACHMENT COMPLICATED BY MACULAR HOLE INVOLVING THE SHORT-TERM PERFLUOROCARBON TAMPONADE

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Rhegmatogenous retinal detachment complicated by macular hole is a rare disorder that is the most challenging in terms of vitreoretinal surgery, and good anatomical outcome is not always associated with high visual functions. Today, vitrectomy, involving macular hole closure with autologous platelet-rich plasma, sealing peripheral retinal tears, and subsequent vitreal cavity tamponade with vitreous substitutes, is considered to be the most effective method for surgical treatment of this disorder. Despite variability of surgical approaches to treatment of rhegmatogenous retinal detachment complicated by macular holes, the search for safe and effective surgical technique, allowing one to achieve benificial morphological and functional outcome with minimal damage to the retinal structures and to minimize the patient's rehabilitation period, is still relevant. The clinical case reported demonstrates the possibility of performing single-stage endovitreal treatment of retinal detachment complicated by macular hole using the autologous conditioned plasma in combination with the short-term perfluorocarbon tamponade. The results of using this technique show its reliability and superior efficiency and ensure good morphological and functional outcome in the postoperative period: restored macular architectonics, macular hole closure, anatomic retinal adhesion, and improved visual functions.

Keywords: rhegmatogenous retinal detachment, macular hole, autologous conditioned plasma, vitreoretinal surgery, perfluorocarbon

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ОДНОМОМЕНТНОЕ ЭНДОВИТРЕАЛЬНОЕ ЛЕЧЕНИЕ ОТСЛОЙКИ СЕТЧАТКИ, ОСЛОЖНЕННОЙ МАКУЛЯРНЫМ РАЗРЫВОМ С КРАТКОВРЕМЕННОЙ ТАМПОНАДОЙ ПЕРФТОРОРГАНИЧЕСКИМ СОЕДИНЕНИЕМ

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Регматогенная отслойка сетчатки, осложненная макулярным разрывом, является редкой и наиболее трудной патологией в плане витреоретинальной хирургии, а успешный анатомический результат не всегда сопровождается высокими зрительными функциями. На сегодняшний день наиболее эффективным методом хирургического лечения данной патологии принято считать витрэктомию с закрытием макулярного разрыва аутоплазмой крови с повышенным содержанием тромбоцитов, блокированием периферических разрывов и последующей тампонадой витреальной полости заместителями стекловидного тела. При всей вариативности хирургических подходов к лечению регматогенной отслойки сетчатки, осложненной сквозным макулярным разрывом, остается актуальным поиск безопасной и эффективной хирургической технологии, позволяющей при минимальном повреждении ретинальных структур достичь высоких морфо-функциональных результатов и минимизировать при этом срок реабилитации пациента. Представленный клинический случай демонстрирует возможность одномоментного микрохирургического лечения регматогенной отслойки сетчатки, осложненной сквозным макулярным разрывом с применением аутологичной кондиционированной плазмы в комбинации с кратковременной тампонадой перфторорганическим соединением. Результаты использования данной технологии показали ее надежность и высокую эффективность, а также обеспечили высокий морфо-функциональный результат в послеоперационном периоде — восстановление макулярной архитектоники, закрытие макулярного разрыва, анатомическое прилегание сетчатки и улучшение зрительных функций.

Ключевые слова: регматогенная отслойка сетчатки, макулярный разрыв, аутологичная кондиционированная плазма, витреоретинальная хирургия, перфторорганическое соединение

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Соблюдение этических стандартов: от пациента получено добровольное информированное согласие на хирургическое лечение и обработку персональных данных.

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Rhegmatogenous retinal detachment complicated by macular hole is a rare disorder that is currently one of the most challenging in terms of vitreoretinal surgery, the good anatomical outcome of which not always ensure high visual functions.

According to the literature, the prevalence of rhegmatogenous retinal detachment complicated by macular hole is 2.3–4% of cases. The disorder occurs predominantly in individuals with high myopia and peripheral retinal tears [1]. Macular holes less often occur secondary to retinal detachment as a result of vitreoretinal traction due to posterior vitreous detachment, eye injury, tangential traction caused by epiretinal fibrosis, or proliferative vitreoretinopathy [1, 2].

The main goal of treatment of rhegmatogenous retinal detachment complicated by macular hole until the end of the 20th century was to achieve anatomic retinal adhesion by sealing peripheral tears without any attempts of the macular defect closure. This resulted in poor functional outcomes and the development of central scotoma [3, 4].

The literature describes clinical cases of two-stage surgical treatment of the combination of these disorders. The second stage surgery aimed at sealing the macular hole is performed some time after restoration of anatomic retinal adhesion. However, such an approach not always ensures restoration of macular architectonics, requires high material costs, and not always guarantees good visual and morphological outcome [5, 6].

Today, three port pars plana vitrectomy involving removal of posterior layers of the vitreous, macular hole closure, sealing peripheral tears followed by the vitreal cavity tamponade with vitreous substitutes (silicone oils of varying viscosity, air-gas tamponade with long resorption period, sterile air) is considered the only effective method for surgical treatment of rhegmatogenous retinal detachment complicated by macular hole allowing one to achieve good anatomic and functional outcome [1, 5, 7–9].

Various surgical methods of macular defect closure have been proposed in order to improve the effectiveness of the macular hole surgical treatment, i.e. to increase the anatomic closure rate and the rate of visual function improvement: mechanical approximation the of the hole edges, internal limiting membrane (ILM) peeling, sealing of the hole with various modifications of the inverted ILM flap, amniotic membrane plug, transplantation of the anterior lens capsule, ILM preservation [1, 7–11].

In recent years, there is growing interest in the methods associated with sealing the macular hole with autologous platelet-rich plasma. Currently, two methods of plasma collection are extensively used in treatment of retinal disorders: PRP, platelet-rich plasma with the platelet levels 3–4 times higher compared to baseline blood levels, and ACP, autologous conditioned plasma with almost no white blood cells and elevated platelet levels (2–3 times higher compared to baseline blood levels). Local application of autologous factors during macular surgery makes it possible to achieve good anatomic and functional outcome and minimize retinal tissue injury during the operation [12–15].

Despite variability of surgical approaches to treatment of rhegmatogenous retinal detachment complicated by macular holes, the search for safe and effective surgical technique, allowing one to achieve anatomic retinal adhesion and restoration of macular architectonics with minimal damage to the retinal structures and to minimize the patient's rehabilitation period, is still relevant.

The clinical case reported demonstrates a single-stage approach to treatment of rhegmatogenous retinal detachment complicated by macular hole.

The aim was to assess the effectiveness and safety of the single-stage approach to endovitreal treatment of rhegmatogenous retinal detachment complicated by macular hole involving sealing a peripheral tear by endolaser photocoagulation, macular hole closure with autologous conditioned plasma, and short-term perfluorocarbon tamponade of the vitreous cavity.

Clinical case

In July 2022, female patient A. aged 60 presented to the Research Center of Ophtalmology of the Pirogov Russian National Research Medical University complaining of the rapid decrease in visual acuity of her left eye and the emergence of dark curtain falling across the left eye peripheral visual field from the top on the nasal and temporal sides. The above developed suddenly five days before the visit. According to medical history, the patient underwent surgery, phacoemulsification of cataract with intraocular lens (IOL) implantation, on both eyes (OU) in 2015.

The patient underwent preoperative comprehensive eye examination involving the use of standard (visometry to determine uncorrected visual acuity (UCVA) and best-corrected visual acuity (BCVA), pneumatonometry, biomicroophthalmoscopy with a MaxField indirect lens MaxField (Ocular Inc.; USA)) and specific assessment methods (B-mode sonography of the eye with the Compact Touch NEW scanner (Quantel Medical; France) and spectral-domain optical coherence tomography (SD-OCT) with the Spectralis HRA+OCT module (Spectralis HRA+OCT, Heidelberg Engineering, Module, OCT-2 85,000 Hz Inc., Germany)).

Initial assessment showed that visual acuity of the left eye (OS) was 0.01 (incorrigible, eccentric viewing), and intraocular pressure (IOP) was 15 mmHg. Ophthalmoscopy OS showed that the anterior segment was intact, and the well-centered IOL was in the capsular bag. Retinal detachment involving the macular zone was found between the 12 and 8 clock h, a flap tear extending for 1 clock h was visible in the peripheral retina, a roundish red-colored defect was found in the macular zone. Ultrasonography revealed subtotal retinal detachment with a height of 9.13 mm and a flap tear in the superior outer quadrant. Macular SD-OCT revealed retinal detachment in the center of the retina and a defect with a diameter of 380 μm penetrating through all retinal layers in the foveal zone (Fig. 1).

The following diagnosis was established based on the patient's comprehensive eye examination, complaints, and medical history: OS Subtotal rhegmatogenous retinal detachment. Macular hole. Pseudophakia.

The patient underwent three port pars plana vitrectomy performed using a disposable 27G tool kit according to standard method with the cut rate of up to 5,500 cpm and vacuums of up to 650 mmHg (Fig. 2). Initial application of the triamcinolone acetonide contrast agent was followed by induction and subsequent removal of the posterior hyaloid membrane and adjacent posterior layers of the vitreous. A flap retinal tear extending for 1 clock h was found when examining the peripheral retina. A perfluoroorganic compound was injected in small increments into the vitreous cavity in order to reduce retinal mobility and ensure smoothing of the detached retina. As a result, adaptation of the detached retina to subadjacent layers was achieved along with the subretinal fluid drainage into the vitreous cavity through the hole. Partial aspiration of the perfluoroorganic compound was performed using active extrusion. The macular zone of the retina was stained with the Membrane Blue-Dual dye injected intravitreally in order to identify ILM, while the zone of macular hole was covered with the perfluoroorganic compound drop allowing us to prevent the dye penetration under the retina. Aspiration of intravitreal dye and the remaining perfluoroorganic compound was followed by the ILM removal with endovitreal forceps 360 degrees around the foveola within the limits of vascular arcades.

The vitreous cavity was once again plugged with the perfluoroorganic compound, the remaining subretinal fluid was aspirated above the zone of the hole. Endolaser photocoagulation of the flap tear extending for 1 clock h was performed.

The perfluoroorganic compound was partially aspirated by active extrusion to a volume of 3–4 diameters of the optic disc over the zone of the macular hole and substituted with the balanced salt solution (BSS). The macular hole edges were approximated to the center using the extrusion cannula until these were in full contact (the cannula tip did not touch the retinal tissue), and the remaining subretinal fluid was aspirated.

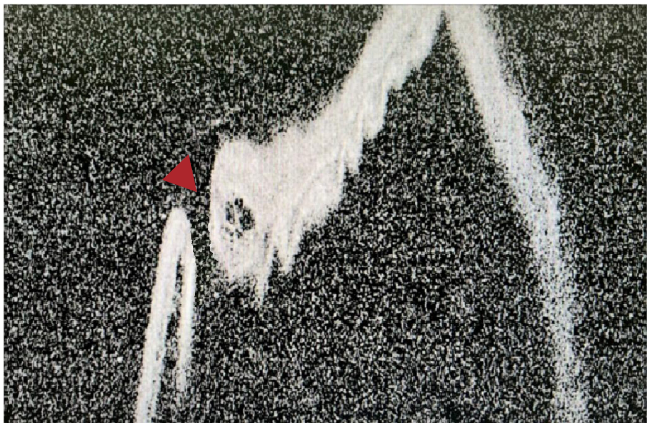

Fig. 1. Spectral domain optical coherence tomography scan of the macular zone (before surgery). Retinal detachment. Macular hole (*red arrow*) with a diameter of 380 μm

Autologous conditioned plasma (ACP) was prepared during surgery using the propietary Arthrex ACP double syringe (RU № FZN 2012/12123 of 08.11.2016) by drawing 15 mL of the patient's venous blood using a 18–20 G butterfly needle with no anticoagulant into the Arthrex ACP syringe. Blood collection was followed by the syringe installation in the ROTOFIX 32A centrifuge (Hettich; Germany) and subsequent centrifugation for 5 min at 1700 rpm.

After aspiration of the remaining perfluoroorganic compound, a syringe with a blunt needle was used to sequentially apply the 0.1 mL ACP drops with the exposure time of up 1 min to form multiple layers in the zone of the macular hole until a faint translucent film was formed within the limits of vascular arcades. The surgical procedure ended with short-term perfluorocarbon tamponade of the vitreous cavity (8 days) aimed at the chorioretinal adhesion formation in the area of peripheral tear and retaining the applied ACP in the macular zone for the macular hole sealing and subsequent regeneration.

Standard drug therapy (antibacterial and anti-inflammatory) was used during the postoperative period.

On day one after surgery the patient reported improvement in visual acuity of her left eye along with no dark curtain in the left eye peripheral visual field; she complained of metamorphopsia. Examination revealed UCVA of 0.05, BCVA of 0.16, and IOP of 18 mmHg. Ophthalmoscopy revealed the translucent fibrin film in the macular zone within the limits of vascular arcades, the tear in the peripheral retina extending for 1 clock h was sealed by edematous coagula, the entire retina was adapted. According to macular SD-OCT, the macular hole edges were closed, and the fibrin film on the retinal surface was visible (Fig. 3).

Based on the SD-OCT findings, lysis of the fibrin film, macular profile shaping, and complete closure of the macular hole were revealed within 7 days during the postoperative period.

On day eight, the second stage surgery was performed using a disposable 27G tool kit. Perfluoroorganic compound was removed by active aspiration. Similarly to the above technology, ACP was prepared during surgery, and the 0.1 mL ACP drops were sequentially applied to the retinal region in the macular zone with the exposure time of up 1 min to form multiple layers until a faint translucent film was formed within the limits of vascular arcades. The surgical procedure ended with substitution of the previously injected BSS with air, first by active aspiration of the solution, and then by passive aspiration of the remaining layer of fluid corresponding to 2–3 diameters of the macula using the cannula. Sclerostomies were sutured after removal of the ports.

One month after surgery the patient reported the improvement in visual acuity OS, the complaints of metamorphopsia declined. Ophthalmic examination showed that UCVA was 0.16, BCVA was 0.3, and IOP was 16 mmHg. Ophthalmoscopy revealed no retinal defect in the macular zone, the tear in the peripheral retina extending for 1 clock h was sealed by pigmented coagula, the entire retina was adherent. According to micropirometry (MAIA, CenterVue Inc.; Italy), the average central retinal sensitivity (CRS) OS was 24.7 dB, fixation was stable. According to macular SD-OCT, the normal foveal profile was formed, the macular hole was closed, and retinal segmentation was partially restored (Fig. 4).

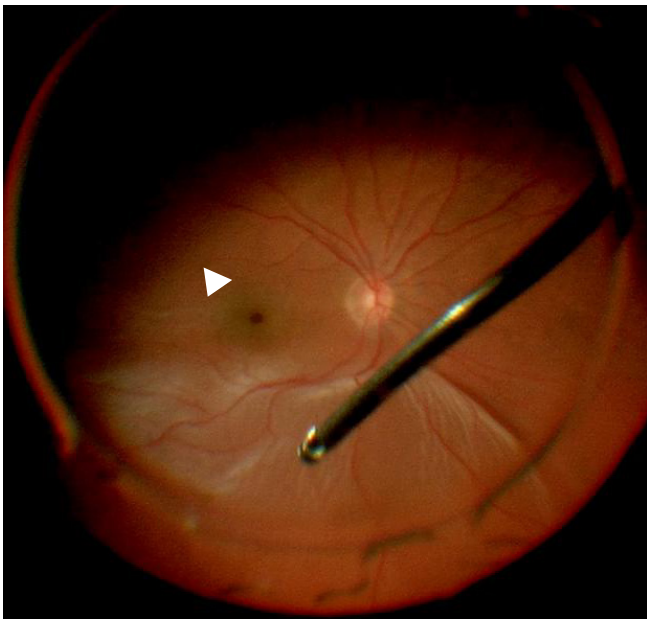

Fig. 2. Intraoperative fundus image: macular hole in the center of the retina (*white arrow*). Retinal detachment in the superior, temporal and inferior quadrants

On the follow-up examination three months after treatment the patient reported improvement in visual acuity of her left eye and no metamorphopsia. Examination revealed improved visual acuity: UCVA was 0.2, BCVA was 0.5, and IOP was 17 mmHg. Ophthalmoscopy revealed a blunted reflex in the macular zone, the tear in the peripheral retina extending for 1 clock h was sealed by pigmented coagula, the entire retina was adherent. The average CRS OS improved to 25.3 dB, and fixation remained stable. SD-OCT revealed a normal macular profile together with partially restored external retinal layers.

The patient had no complaints on the follow-up examination six months after surgery. Examination showed that her visual acuity was stable: UCVA was 0.2, BCVA was 0.5, and IOP was 15 mmHg. Ophthalmoscopy revealed a blunted reflex in the macular zone, the entire retina was adherent, and the tear in the peripheral retina extending for 1 clock h was sealed by pigmented coagula. According to micropirometry, the average CRS OS improved to 26.1 dB, and fixation was stable. SD-OCT revealed a preserved macular profile together with partially restored segmentation of the external retinal layers (Fig. 5).

Clinical case discussion

Rhegmatogenous retinal detachment coexisting with macular hole is associated with poorer prognosis of beneficial outcome in terms of morphological and functional parameters. The surgeon has to execute a number of additional intraoperative manipulations increasing the risk of intra- and postoperative complications during surgery. Today, the issue of choosing the effective and safe method for surgical treatment of

rhegmatogenous retinal detachment complicated by macular hole is still relevant.

According to the literature, the majority of reported surgical techniques for treatment of this combination of disorders end with the silicone oil tamponade of the vitreous cavity followed by the silicone oil removal after 3–6 months [1, 7, 8, 11, 16] or with the air-gas tamponade [5, 17]. However, silicone oil is unable to tightly press the retina at the posterior pole. It is well known that there is a layer of intraocular fluid between silicone oil and the retina, that is why the conditions are not optimal for the macular hole sealing and regeneration (compared to the perfluorocarbon tamponade). Furthermore, the long-term presence of silicone oil in the vitreous cavity may result in such complications, as secondary ocular hypertension, lens opacity, contact keratopathy, perisilicone proliferation, cystoid macular edema. Moreover, silicone oil induces high hypermetropia and irregular astigmatism, thereby significantly reducing visual acuity throughout the period of tamponade [18]. Air-gas tamponade of the vitreous cavity forces the patient to stay in prone position for a long time, reduces his/her quality of life during the period of tamponade, limits the possibility of ophthalmoscopy-based control over the retinal adaptation and the macular hole closure during the postoperative period, promotes the development of cataract, retinal folds, and peripheral retinal tears.

The reported use of short-term perfluorocarbon tamponade of the vitreous cavity ensures reliable adaptation of the retina to subadjacent tissues, contributes to formation of strong chorioretinal adhesion and prevents displacement of the retina relative to subadjacent layers. Perfluorocarbon tamponade ensures stable fibrin film retention and tight adhesion of fibrin to the retinal defect, thereby reducing the risk of the fibrin film displacement relative to the macular hole and contributing to the macular defect strong sealing and effective regeneration. The use of this vitreous substitute does not require staying in certain forced position and does not reduce the patient's mobility in the early postoperative period. No complications develop during the short period of perfluorocarbon tamponade of the vitreous cavity.

The possibility of using ACP (under protection of perfluorocarbon tamponade) allows maximum use of its reparative and regenerative potential. This ensures optimal restoration of the macular zone morphology and makes it possible to achieve high visual functions.

The use of proposed microsurgical approach for treatment of rhegmatogenous retinal detachment complicated by macular hole resulted in complete anatomic adhesion of the retina, restored macular architectonics of the retina, and visual function improvement.

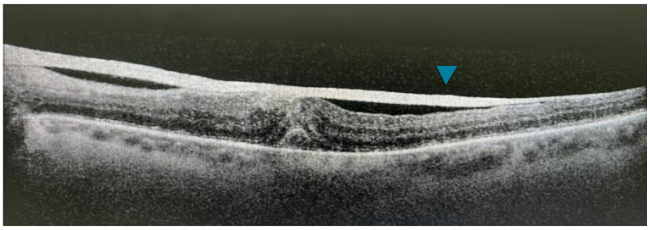

Fig. 3. Spectral domain optical coherence tomography scan of the macular region (24 h after surgery). The macular hole is closed, there is a hyperreflective structure represented by the fibrin film on the retinal surface (*blue arrow*)

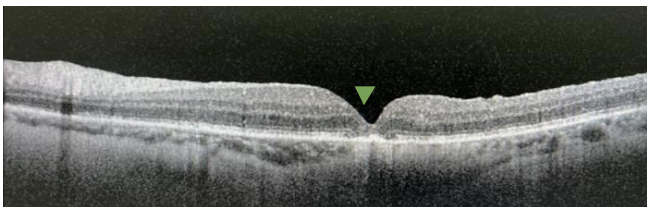

Fig. 4. Spectral domain optical coherence tomography scan of the macular region (one month after surgery). Apparent macular profile (*green arrow*). The "retinal pigment epithelium — Bruch's membrane" complex and discontinuous external limiting membrane are visible

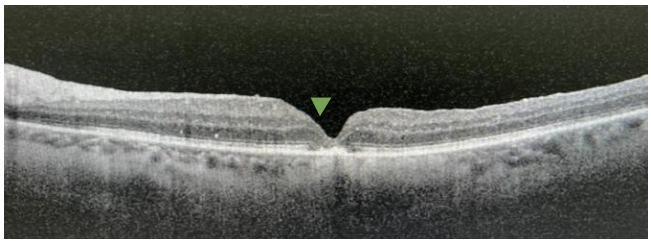

Fig. 5. Spectral domain optical coherence tomography scan of the macular region (six months after surgery). Apparent macular profile (*green arrow*). The "retinal pigment epithelium — Bruch's membrane"complex is visible. Partially restored segmentation of the external retinal layers (discontinuous external limiting membrane), partially restored photoreceptor zone of the retina

CONCLUSION

The proposed technique for endovitreal microsurgery of rhegmatogenous retinal detachment complicated by macular hole involving the use of endolaser photocoagulation, autologous conditioned plasma, and short-term perfluorocarbon tamponade of the vitreous cavity proved to be reliable and highly effective and ensured good morphological and functional results, i.e. restoration of macular architectonics, macular hole closure, anatomic retinal adhesion, and visual function improvement, in the postoperative period. The deeper analysis requires further testing of the proposed technology.

References

1. Stappler T, Montesel A, Konstantinidis L, Wolfensberger TJ, Eandi CM. Inverted internal limiting membrane flap technique for macular hole coexistent wirh rhegmatogenous retinal detachment. Retina. 2022; 42 (8): 1491–7.
2. Cunningham MA, Tarantola RM, Folk JC, Sohn EH, Boldt HC, Graff JA et al. Proliferative vitreoretinopathy may be a risk factor in combined macular hole retinal detachment cases. Retina. 2013; 33 (3): 579–85.
3. Chignell AH, Billington B. The treatment of macular holes by pars plana vitrectomy and internal air/SF6 exchange. Graefes Arch Clin Exp Ophthalmol. 1986; 224 (1): 67–68.
4. Gonvers M, Machemer R. A new approach to treating retinal detachment with macular hole. Am J Ophthalmol. 1982; 94 (4): 468–72.
5. Singh AJ. Combined or sequential surgery for management of rhegmatogenous retinal detachment with macular holes. Retina. 2009; 29 (8): 1106–10.
6. Balashevich LI, Platov EA, Nigmatov BF. Sluchaj xirurgicheskogo lecheniya regmatogennoj otslojki setchatki s makulyarnym razryvom. V sbornike: Problemy sovremennoj mediciny: aktual'nye voprosy. Sbornik nauchnyx trudov po itogam mezhdunarodnoj nauchno-prakticheskoj konferencii; 6 noyabrya 2014 g; Krasnoyarsk; 37–39. Russian.
7. Zhao PP, Wang S, Liu N, Shu ZM, Zhao JS. A review of surgical outcomes and advances for macular holes. J Ophthalmol. 2018; 1–10
8. Abouhussein MA, Elbaha SM, Aboushousha M. Human amniotic membrane plug for macular holes coexisting with rhegmatogenous

retinal detachment. Clin Ophthalmol. 2020; 14: 2411–6.
9. Shukla D, Kalliath J, Srinivasan K, Neelakantan N, Rajendran A, Naresh KB, et al. Management of rhegmatogenous retinal detachment with coexisting macular hole: a comparison of vitrectomy with and without internal limiting membrane peeling. Retina. 2013; 33 (3): 571–78.
10. Ryan EH Jr, Bramante CT, Mittra RA, Dev S, Bennett SR, Williams DF, et al. Management of rhegmatogenous retinal detachment with coexistent macular hole in the era of internal limiting membrane peeling. Am J Ophthalmol. 2011; 152 (5): 815–9.
11. Liu X, Huang J, Zhou R, Jiang Z, Chen H, Chen W, et al. Comparison of internal limiting membrane peeling with the inverted internal limiting membrane flap technique for rhegmatogenous retinal detachment coexisting with macular hole. Retina. 2022; 42 (4): 697–703.
12. Krupina EA. Xirurgicheskoe lechenie idiopaticheskogo makulyarnogo razryva s primeneniem bogatoj trombocitami plazmy krovi [dissertaciya]. M., 2019. Russian.
13. Popov EM, Kulikov AN, Churashov SV, Gavrilyuk IO, Egorova EN, Abbasova AI. Sravnenie pokazatelej poluchaemoj raznymi sposobami autoplazmy, ispol'zuemoj dlya lecheniya pacientov s makulyarnym razryvom. Oftal'mologicheskie vedomosti. 2021; 14 (4): 27–34. Russian.
14. Arsyutov DG. Ispol'zovanie autologichnoj kondicionirovannoj plazmy, obogashhennoj trombocitami, v xirurgii regmatogennoj otslojki setchatki s central'nym i perifericheskimi razryvami. Acta biomedica scientifica. 2019; 4 (4): 61–65. DOI: 10.29413/ABS.2019-4.4.8. Russian.
15. Bajborodov YaV, Zhogolev KS. Autologichnaya kondicionirovannaya plazma — inducirovannaya fibrinnaya plenka v xirurgicheskom lechenii makulyarnyx razryvov. Sovremennye texnologii v oftal'mologii. 2020. 4: 283. Russian.
16. Xurdaeva AG, Zaxarov VD, Shkvorchenko DO, Krupina EA, Norman KS, Yuxananova AV. Xirurgicheskoe lechenie regmatogennoj otslojki setchatki, oslozhnennoj makulyarnym razryvom, s primeneniem bogatoj trombocitami plazmy krovi i lokal'nym okrashivaniem vnutrennej pogranichnoj membarny. Sovremennye texnologii v oftal'mologii. 2019; 4 (29): 267–70. Russian.
17. O'Driscoll AM, Goble RR, Kirkby GR. Vitrectomy for retinal detachments with both peripheral retinal breaks and macular holes. An assessment of outcome and the status of the macular hole. Retina. 2001; 21 (3): 221–5.
18. Taxchidi XP, Metaev SA, Glinchuk NYa, Gazal NA. Obosnovanie rannego udaleniya silikonovogo masla pri lechenii tyazhelyx otsloek setchatki razlichnogo geneza. Vestnik Orenburgskogo gosudarstvennogo universiteta, 2004; 5: 60–65. Russian.

Литература

1. Stappler T, Montesel A, Konstantinidis L, Wolfensberger TJ, Eandi CM. Inverted internal limiting membrane flap technique for macular hole coexistent wirh rhegmatogenous retinal detachment. Retina. 2022; 42 (8): 1491–7.
2. Cunningham MA, Tarantola RM, Folk JC, Sohn EH, Boldt HC, Graff JA et al. Proliferative vitreoretinopathy may be a risk factor in combined macular hole retinal detachment cases. Retina. 2013; 33 (3): 579–85.
3. Chignell AH, Billington B. The treatment of macular holes by pars plana vitrectomy and internal air/SF6 exchange. Graefes Arch Clin Exp Ophthalmol. 1986; 224 (1): 67–68.
4. Gonvers M, Machemer R. A new approach to treating retinal detachment with macular hole. Am J Ophthalmol. 1982; 94 (4): 468–72.
5. Singh AJ. Combined or sequential surgery for management of rhegmatogenous retinal detachment with macular holes. Retina. 2009; 29 (8): 1106–10.
6. Балашевич Л. И., Платов Е. А., Нигматов Б. Ф. Случай хирургического лечения регматогенной отслойки сетчатки с макулярным разрывом. В сборнике: Проблемы современной медицины: актуальные вопросы. Сборник научных трудов по итогам международной научно-практической конференции; 6 ноября 2014 г.; Красноярск; 37–39.
7. Zhao PP, Wang S, Liu N, Shu ZM, Zhao JS. A review of surgical outcomes and advances for macular holes. J Ophthalmol. 2018; 1–10
8. Abouhussein MA, Elbaha SM, Aboushousha M. Human amniotic membrane plug for macular holes coexisting with rhegmatogenous retinal detachment. Clin Ophthalmol. 2020; 14: 2411–6.
9. Shukla D, Kalliath J, Srinivasan K, Neelakantan N, Rajendran A, Naresh KB, et al. Management of rhegmatogenous retinal detachment with coexisting macular hole: a comparison of vitrectomy with and without internal limiting membrane peeling. Retina. 2013; 33 (3): 571–78.
10. Ryan EH Jr, Bramante CT, Mittra RA, Dev S, Bennett SR, Williams DF, et al. Management of rhegmatogenous retinal detachment with coexistent macular hole in the era of internal limiting membrane peeling. Am J Ophthalmol. 2011; 152 (5): 815–9.
11. Liu X, Huang J, Zhou R, Jiang Z, Chen H, Chen W, et al. Comparison of internal limiting membrane peeling with the inverted internal limiting membrane flap technique for rhegmatogenous retinal detachment coexisting with macular hole. Retina. 2022; 42 (4): 697–703.
12. Крупина Е. А. Хирургическое лечение идиопатического макулярного разрыва с применением богатой тромбоцитами плазмы крови [диссертация]. М., 2019.
13. Попов Е. М., Куликов А. Н., Чурашов С. В., Гаврилюк И. О., Егорова Е. Н., Аббасова А. И. Сравнение показателей получаемой разными способами аутоплазмы, используемой для лечения пациентов с макулярным разрывом. Офтальмологические ведомости. 2021; 14 (4): 27–34.
14. Арсютов Д. Г. Использование аутологичной кондиционированной плазмы, обогащенной тромбоцитами, в хирургии регматогенной отслойки сетчатки с центральным и периферическими разрывами. Acta biomedica scientifica. 2019; 4 (4): 61–65. DOI: 10.29413/ABS.2019-4.4.8.
15. Байбородов Я. В., Жоголев К. С. Аутологичная кондиционированная плазма — индуцированная фибринная пленка в хирургическом лечении макулярных разрывов. Современные технологии в офтальмологии. 2020. 4: 283.
16. Хурдаева А. Г., Захаров В. Д., Шкворченко Д. О., Крупина Е. А., Норман К. С., Юхананова А. В. Хирургическое лечение регматогенной отслойки сетчатки, осложненной макулярным разрывом, с применением богатой тромбоцитами плазмы крови и локальным окрашиванием внутренней пограничной мембарны. Современные технологии в офтальмологии. 2019; 4 (29): 267–70.
17. O'Driscoll AM, Goble RR, Kirkby GR. Vitrectomy for retinal detachments with both peripheral retinal breaks and macular holes. An assessment of outcome and the status of the macular hole. Retina. 2001; 21 (3): 221–5.
18. Тахчиди Х. П., Метаев С. А., Глинчук Н. Я., Газаль Н. А. Обоснование раннего удаления силиконового масла при лечении тяжелых отслоек сетчатки различного генеза. Вестник Оренбургского государственного университета, 2004; 5: 60–65.