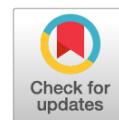


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Spontaneous closure of macular holes in children

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ABSTRACT

AIM: This study aimed to analyze clinical cases of spontaneous macular hole (MH) closure in children and determine the optimal approach for managing patients with this disease.

MATERIAL AND METHODS: Data from 32 patients aged 6–17 years (average: 11.3 years) were evaluated, including 32 eyes with a full thickness macular hole and 1 eye with a lamellar macular hole. All patients were treated in the Department of Pediatric Ocular Pathology of the Helmholtz National Medical Research Center of Eye Diseases in 2013–2023. They underwent a comprehensive ophthalmological examination, including optical coherence tomography (OCT) of the macular area.

RESULTS: Spontaneous MH closure was observed in five eyes (15.2%) of five patients (15.6%). The etiological factor of the disease was ocular contusion in two cases, photodamage in one case, and an inflammatory process in the posterior segment of the eye in two cases. A small diameter MH (100–261 μm) and its overgrowth soon after formation were common to all patients, that is, less than 2 months in 3 of 5 children and within 6 months in all patients.

CONCLUSION: Spontaneous closure of MH with a small diameter and in the early stages after its formation is rare in pediatric patients. For MH with a diameter of up to 200 μm according to OCT and the absence of other indications for surgical treatment, a wait-and-see approach for 3 months with regular (once a month) examination is recommended. In cases with MH closure tendency, continued follow-up is crucial; if it persists after 3 months or increases at any period of follow-up, surgical treatment is indicated.

Keywords: macular hole; spontaneous closure; pediatric patients; optical coherence tomography.

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Самопроизвольное закрытие макулярных разрывов у детей

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АННОТАЦИЯ

Цель. Проанализировать клинические случаи самопроизвольного закрытия макулярных разрывов (МР) у детей и определить оптимальную тактику ведения пациентов с этим заболеванием.

Материал и методы. Проанализированы данные 32 пациентов в возрасте от 6 до 17 лет (в среднем 11,3), в том числе 32 глаза со сквозным, один — с ламеллярным макулярным разрывом. Все больные находились на лечении в отделе патологии глаз у детей НМИЦ глазных болезней им. Гельмгольца в 2013–2023 гг. Всем детям выполнено комплексное офтальмологическое обследование, включая оптическую когерентную томографию (ОКТ) макулярной зоны.

Результаты. Самопроизвольное закрытие МР наблюдалось в 5 глазах (15,2%) 5 пациентов (15,6%). В 2 случаях этиологическим фактором заболевания была контузия глаза, в 1 — фотоповреждение, в 2 — воспалительный процесс в заднем отрезке глаза. Общим для всех пациентов был небольшой минимальный диаметр МР (100–261 мкм) и его зарастание в ближайшие сроки после формирования, а именно, менее 2 месяцев у 3 из 5 детей, у всех — в пределах 6 месяцев.

Заключение. Самопроизвольное закрытие МР у детей наблюдается относительно редко, при небольших отверстиях и в ранние сроки после их формирования. При МР с минимальным диаметром до 200 мкм по данным ОКТ и отсутствии других показаний к оперативному лечению целесообразна выжидательная тактика в течение 3 месяцев с регулярным (1 раз в месяц) обследованием. При тенденции к закрытию МР необходимо продолжение наблюдения, при его персистенции через 3 месяца или увеличении на любом сроке наблюдения показано хирургическое лечение.

Ключевые слова: макулярный разрыв; самопроизвольное закрытие; дети; оптическая когерентная томография.

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BACKGROUND

A macular hole (MH) is a full thickness defect of the neurosensory retina that involves the foveal area. This disease is less common in children than in adults. According to a few studies, the main etiological factor of MH is eye trauma [1, 2]. Isolated MHs rarely lead to retinal detachment; however, they significantly reduce visual acuity, and its increase is possible only when the MH is closed.

Currently, the standard treatment for MH is vitrectomy with removal of the posterior hyaloid membrane and peeling of the internal limiting membrane (ILM) and vitreous tamponade depending on the clinical situation with sterile air, expanding gases, or silicone oil. To increase efficiency, various modifications of the surgery have been proposed, including the use of biostimulants (platelet concentrate, blood, serum, thrombin, transforming growth factor beta); closure of the MH with autograft of the ILM, retina, lens capsule, and amnion; laxative retinotomy; and subretinal hydrodissection [1–7].

However, some studies have reported cases of spontaneous MH closure of various etiologies in pediatric patients [8–20] and adults [18–33], accompanied by restoration of the foveal region microstructure and a significant increase in visual acuity in most patients. The indications for choosing between wait-and-see approach and surgical treatment of MH in general and particularly in pediatric patients are unclear.

This study aimed to analyze clinical cases of spontaneous MH closure in children and determine the optimal approach for managing patients with this disease.

MATERIAL AND METHODS

Data from 32 patients (28 boys, 4 girls) aged 6–17 years (average: 11.3 years) were analyzed, including 32 eyes with full thickness MH and 1 eye with lamellar MH. The patients were treated in the Department of Pediatric Ocular Pathology of the Helmholtz National Medical Research Center of Eye Diseases (hereinafter referred to as the Center) in 2013–2023. The children underwent a comprehensive ophthalmological examination, including optical coherence tomography (OCT) of the macular area using Spectralis HRA+OCT (Heidelberg, Germany) or RS-3000 Advance AngioScan (Nidek, Japan), ultrasound B-scan (US-4000 ECHOSCAN, Nidek, Japan), and, in some cases, photographic recording of the fundus (Eidon, True Color Confocal Scanner, USA).

RESULTS

Spontaneous MH closure was observed in five eyes (15.2%) of five patients (15.6%). The clinical cases were as follows:

1. Patient G: 8 years old. During a preventive examination by an ophthalmologist, an uncorrectable decrease in visual

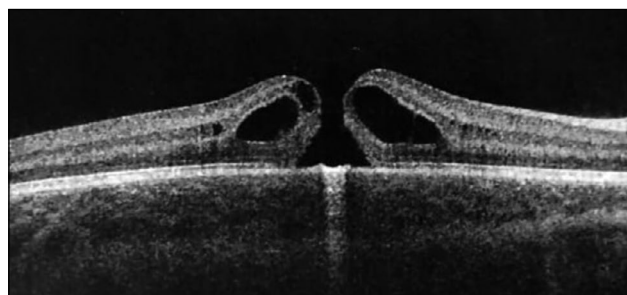


Fig. 1. Optical coherence tomogram of patient 1. Macular hole.

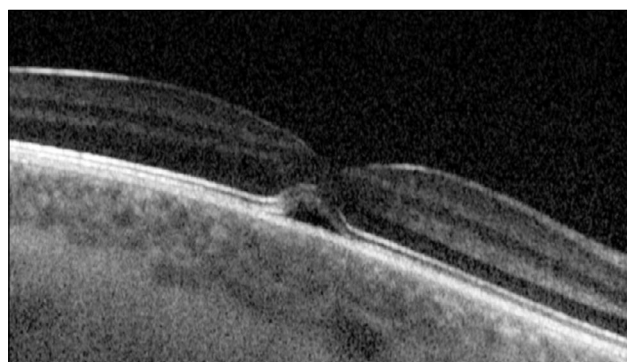


Fig. 2. Optical coherence tomogram of patient 1 after macular hole closure.

acuity to 0.07 was found in the right eye; examination and OCT showed MH with a minimum diameter of 100 μm and basal diameter of 200 μm , with intraretinal areflective cavities along the hole edge (Fig. 1).

MH persistence could not be accurately determined; 2 months before the ophthalmological examination, the child was playing with a laser pointer. After 2.5 months, an examination at the Center and ophthalmoscopy and OCT revealed MH closure and restoration of the foveal depression contour with preservation of local neuroepithelial detachment in the foveal area (Fig. 2). The corrected visual acuity of the right eye was 1.0.

2. Patient S: 9 years old. The patient visited an ophthalmologist with complaints of decreased vision in the left eye for 2–3 months; examination revealed MH in both eyes. The exact time of MH onset was unknown; 3.5 months before the examination, the patient had a head injury from a swimming-pool nosing. The child was referred to the Center for surgical treatment. When examined 3 weeks later at the Center, ophthalmoscopy and OCT of the right eye showed full thickness MH, with a minimum size of 140 μm and basal size of 157 μm , and areflective cavities were noted at the inner edge of the hole at the level of the inner nuclear layer (Fig. 3).

Furthermore, a full thickness MH was found in the left eye, with a minimum size of 703 μm and basal size of 914 μm , and areflective cavities were found at the level of the outer nuclear layer along the hole edge. The corrected visual acuity was 1.0 on the right eye and 0.4 on the left. Surgical treatment of the left eye was performed.

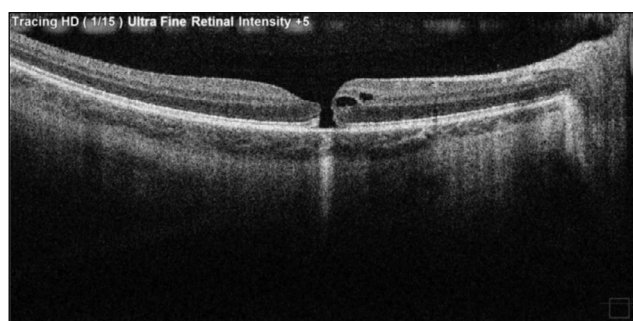


Fig. 3. Optical coherence tomogram of patient 2. Macular hole in the right eye retina.



Fig. 4. Optical coherence tomogram of spontaneous closure of the right eye macular hole in patient 2, 2.5 months after macular hole detection.

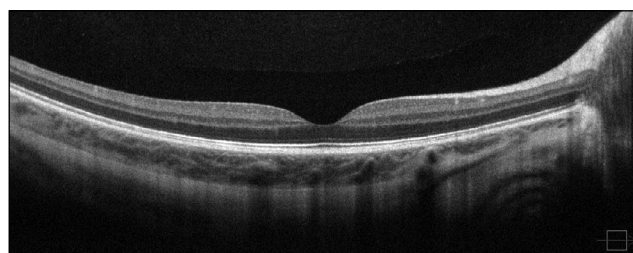


Fig. 5. Optical coherence tomogram of spontaneous closure of the right eye macular hole in patient 2, 12.5 months after macular hole detection.

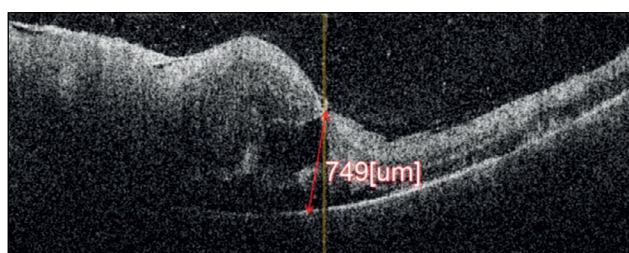


Fig. 6. Optical coherence tomogram of the macular zone of patient 3 upon admission.

An examination conducted 1.5 months later revealed spontaneous MH closure in the right eye. OCT showed that the layers of the right eye retina were differentiated; a defect was noted at the level of the ellipsoid zone and outer segments of the photoreceptors in the center (Fig. 4).

After 10 months, examination displayed complete restoration of the structure of the central zone of the right eye retina. The thickness of the retina central part was 208 μm (Fig. 5), with visual acuity maintained at 1.0.

3. Patient G: 15 years old. The patient visited the Center 3 weeks after onset of thrombosis of the central retinal vein of the left eye presumably due to angiitis. Upon admission, the following were noted: the boundaries of the optic disc were not visible in the fundus of the left eye; the vessels of the lower bundles were discoverable; there were no reflexes in the macula; there was serous retinal

detachment; multiple retinal hemorrhages were detected in the posterior pole region and middle periphery from above; there were preretinal and retinal hemorrhages in the periphery on 1–3 and 7–8 o'clock position; and there was yellowish subretinal exudate at 4–10 o'clock position. OCT detected high neuroepithelial detachment and retinal prehole in the left macular zone (Fig. 6). Visual acuity was 0.01 eccentric and not correctable.

After 2 days, ophthalmoscopy and OCT revealed full thickness MH with a minimum diameter of 194 μm (Fig. 7).

After 8 days, during the anti-inflammatory and absorbable therapy for retinal detachment, a decrease in the prominence of the optic nerve head, retinal hemorrhages, and MH was noted. OCT showed that the minimum diameter of the hole was 70 μm , and neuroepithelial detachment persisted (Fig. 8).

Examination 1 month and 3 weeks after detection revealed MH closure. OCT of the macular zone exhibited



Fig. 7. Fundus (a) and optical coherence tomogram (b) of patient 3 with a formed macular hole.

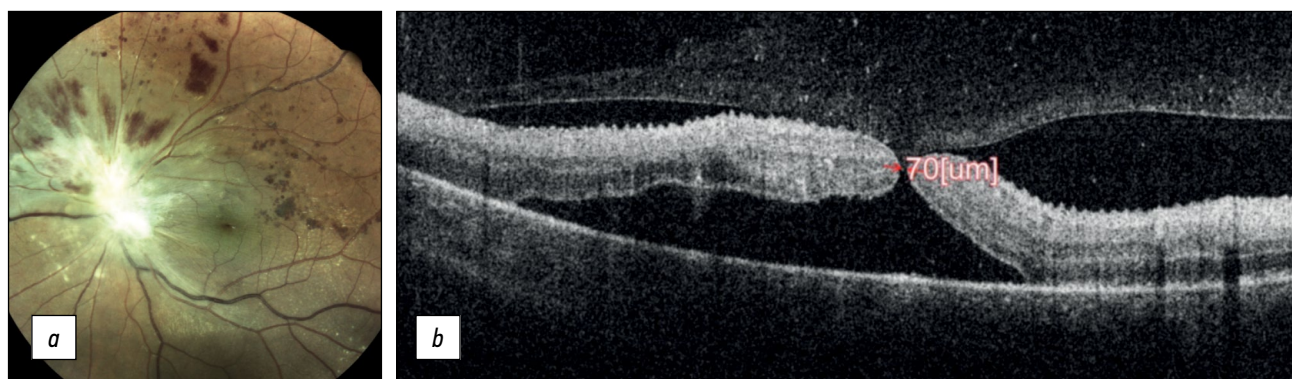


Fig. 8. Fundus image (a) and optical coherence tomogram (b) of patient 3. Improvement of macular hole closure.

decreased height of the neuroepithelial detachment and a 365 μm thickness of the retina central part (Fig. 9). The corrected visual acuity was 0.2–0.3.

4. Patient D: 13 years old. The patient received a knee strike to the right eye while playing football. On day 2 after the injury, he was hospitalized at the primary healthcare facility, where a local retinal detachment with a peripheral rupture was detected. Ten days later, a full thickness MH was revealed. The child was referred to the Center. Further, 1.5 months after MH in the fundus of the right eye was detected, the following were observed: the optic disc was pale pink, the boundaries were clear, the vessels had no abnormalities, there was a full thickness MH in the center, the retina was adjacent, and there was retinal detachment on the periphery at 4–9 o'clock position with a hole at 7 o'clock position. A surgery was performed on the right with local

episcleral filling, after which spontaneous MH closure and retinal detachment reattachment was noted (Fig. 10). The visual acuity of the right eye was 0.2 upon admission, and 0.3 after MH closure. Vitreoretinal contour deformation of the foveolar depression, photoreceptor layer disorganization in the fovea with an areflective cavity, and slit-like detachment of the parafoveolar neuroepithelium were detected. The thickness of the central part of the retina was 152 μm .

5. Patient K: 10 years old. The patient received treatment at the primary healthcare facility for neuroretinitis of the left eye of unknown etiology. During treatment, posterior vitreous detachment (PVD) and lamellar MH were noted (Fig. 11). Therefore, the patient was referred to the National Medical Research Center of Eye Diseases. When contacting the Center after 2 months, complete PVD formation in the macula with spontaneous MH closure was observed (Fig. 12). Deformed contour of the foveolar depression, disorganization

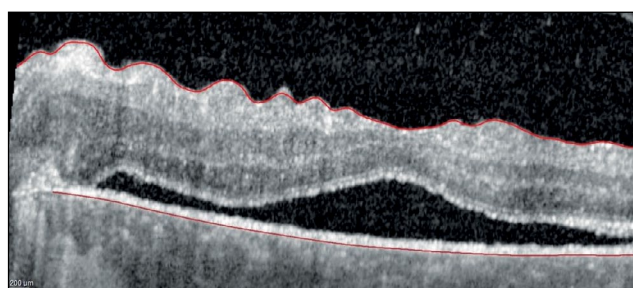


Fig. 9. Optical coherence tomogram of macular hole closure in patient 3.

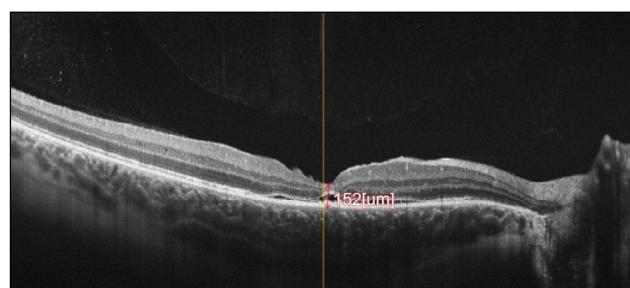


Fig. 10. Optical coherence tomogram of the macular zone of patient 4 after surgery.

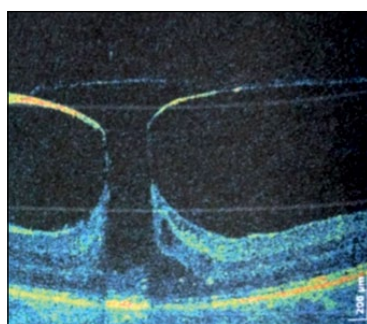


Fig. 11. Optical coherence tomogram of lamellar macular hole in patient 5.



Fig. 12. Optical coherence tomogram of macular hole closure in patient 5.

Table 1. Characteristics of patients and parameters of macular hole in cases of its spontaneous closure

Patient	Age (years), gender	Etiology of macular hole	Minimum macular hole size, presence of retinal cysts (+/-)	Duration of macular hole existence before closure (months)	Corrected visual acuity	
					With macular hole	After spontaneous closure of a macular hole
1	8, m	photodamage (?)	100, c+	no more than 4.5	0,07	1,0
2	9, m	Contusion	140, c+	no more than 6	1,0	1,0
3	15, m	CRV thrombosis *** associated with angiitis	261, c-	less than 2	0,01	0,2–0,3
4	13, m	contusion	n. d., c-	1,5	0,2	0,3
5	10, f	posterior uveitis	C+	no more than 2	0,01	0,01

Note: m, male; f, female; CRV, central retinal vein; n.d., no data.

of the ellipsoid zone and outer segments of photoreceptors in the fovea, single small areflective cavities in the middle layers of the retina in the parafovea, and posterior vitreous detachment with attachment to the optic nerve head were noted.

Table 1 presents data from patients with spontaneous MH closure.

Moreover, spontaneous MH closure of various etiologies was detected in 15.6% of all pediatric patients with MH who applied to the Center. MH with a small minimum diameter (100–261 μm) and its closure in the immediate period after formation were common to all patients, i.e., less than 2 months in 3 of 5 pediatric patients and within 6 months in all patients. MH closure in 3 of 5 pediatric patients was accompanied by increased visual acuity; in one patient, it was initially high (1.0). In one child, visual acuity in the immediate period after MH closure did not change significantly due to the destruction of photoreceptors in the center and postinflammatory atrophy of the optic nerve.

DISCUSSION

MH can be caused by damage to the central zone of the retina of various etiologies. In children, MHs are more often of traumatic origin; in adults, in most cases, they are caused by pathological vitreoretinal traction in the fovea, called idiopathic MHs. According to single studies, the rate of spontaneous closure of traumatic MH varies widely, ranging from 10.7% to 66.7% (average: 37%) [16, 18, 20, 29, 34, 35]. Spontaneous MH closure was detected in 15.6% of cases among the pediatric patients we studied.

Predictors of spontaneous MH closure are being actively studied. Analysis showed that most of spontaneous MH closures occur in the early stages after their formation, that is, in 66% of cases from 4 days to 3 months and in 92% of cases in the first 6 months [8–33, 35]. Similar results were obtained in a prospective study of traumatic MHs. Thus, the average time of spontaneous closure was 2.5 ± 1.6 months, and 80% of MHs closed within 3 months [34]. Unfortunately, in children, owing to the absence of complaints, the exact

time of MH formation often cannot be determined. However, considering the maximum expected persistence, in 3 of the 5 patients under follow-up, spontaneous MH occurred in the first 2 months and, in all of them, within 6 months after formation. These data and the fact that the long-term persistence of MH can lead to irreversible changes in photoreceptors and worsens the functional prognosis [1] are the bases for recommending the wait-and-see approach with careful follow-up for no more than 3–6 months after MH occurrence.

Spontaneous closure is observed mainly with relatively small MHs. Several studies have assessed the MH size only in relation to the optic disc diameter. Moreover, in all cases of spontaneous closure of traumatic MH, the initial hole size did not exceed 0.1–0.2 disc diameters [10, 15]. In patients who underwent OCT, as a rule, the size of the MH (minimum, average, or maximum) was not indicated. Clearly, in cases wherein one parameter is given, the minimum size is considered. Moreover, the size of spontaneously closed MHs in 67% of patients was within 200 μm [9, 11, 14, 28, 31]. Notably, MHs larger than 200 μm in all cases closed within the immediate period after injury (from 1 week to 2 months) [8, 13, 17, 24, 32].

According to Miller et al., spontaneous closure of traumatic MH was observed more often in children (50%) than in adults (28.8%), which is because of the greater ability of eye tissue regeneration in children [29]. However, these differences were not statistically significant ($p=0.440$), and whether other MH parameters (size, persistence, etc.) were compared was not indicated.

Furthermore, Chen et al. revealed that cystoid edema of the retina around the hole worsens the prognosis of spontaneous MH closure, which was noted in 10% of spontaneously closed and in 76.5% of nonclosed MHs ($p=0.001$) [18]. Similar data were obtained by Chen et al. [34]. Simultaneously, Lei et al. did not reveal a significant difference in the incidence of intraretinal cavities, while detecting them in 25% of spontaneously closed and 36.5% of nonclosed MHs ($p>0.05$) [20]. In the present study, cyst-like changes in the retina around the hole were detected in 3 of 5 patients.

The mechanisms of spontaneous MH closure are not fully understood and obviously differ between patients. The established factors are proliferation of retinal tissue from the MH edges by the formation of a “bridge”— the leading mechanism in most of our cases; formation of an epiretinal membrane over the hole and its subsequent contraction, which leads to a reduction in the hole and promotes the proliferation of retinal cells; and occurrence of PVD which reduces retinal traction [12, 15, 36, 37]. PVD occurs rarely in traumatic MHs, which is dominant in childhood (1.6–11.8%) [1, 20, 29]; thus, this mechanism probably is not significant. In contrast, it is believed that an intact posterior hyaloid membrane in the absence of changes in the vitreous body may contribute to spontaneous MH closure. Moreover, as noted in our patient with neuroretinitis, PVD can contribute to spontaneous MH closure in the presence of vitreoretinal traction.

CONCLUSION

Spontaneous closure of MH with small holes and in the early stages after their formation occurs rarely (15.6%) in pediatric patients. Therefore, according to OCT data and the absence of other indications for surgical treatment, a wait-and-see approach for 3 months with regular (once a month) examination is recommended for MH with a minimum diameter of up to 200–250 μm . In cases with MH closure tendency, continued follow-up is indicated. However, if it persists after

3 months or increases at any period of follow-up, surgical treatment is required. Considering the potential risks and costs of surgical intervention, further study of the mechanisms and predictors of spontaneous MH closure in pediatric patients is warranted to optimize the management approach of such patients.

ADDITIONAL INFO

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

Author contribution. All authors confirm that their authorship complies with the international ICMJE criteria (all authors made a significant contribution to the development of the concept, research and preparation of the article, read and approved the final version before publication). The largest contribution is distributed as follows: Lyudmila A. Katargina — conception and development of the study design, treatment, writing the text and editing the article; Ekaterina V. Denisova, Elena N. Demchenko, Natalya A. Osipova — examination of patients, collection, analysis of data, writing the text of the article, Maria V. Belova — examination of patients.

Consent for publication. Written consent was obtained from the patient's parents for publication of relevant medical information and all of accompanying images within the manuscript in Russian Pediatric Ophthalmology.

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