

## A Modern Approach to the Treatment of Retinopathy of Premature Infants Using Retinal Laser Coagulation

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**Annotation:** The study was conducted on 120 eyes of 60 premature infants (gestation period – 25–31 weeks, birth weight – 670–1630 g, age – 5–8 weeks) with various stages of ROP. Voluntary informed consent for the implementation of treatment and diagnostic measures was obtained from all parents. All children underwent a comprehensive diagnostic examination, including indirect binocular ophthalmoscopy, anterior segment biomicroscopy, digital retinoscopy using the wide-field digital retinal pediatric video system "RetCam-3" (Massie Research Laboratories Inc, USA). Interpretation of diagnostic study data was performed in accordance with the developed clinical and morphometric classification [2]. All patients were divided into two groups depending on the laser coagulation method. The main group consisted of 70 eyes of 35 newborns with active ROP, on which we performed laser coagulation of the retina. Of these, stage II ROP with an unfavorable type of process progression was noted in 11 eyes, stage III with an unfavorable type of process progression - in 3 eyes, posterior aggressive ROP - in 9 eyes, of which 35 eyes were at the stage of early clinical manifestations, 12 eyes at the manifestation stage. The control group included 100 eyes of 50 infants, who underwent only conservative treatment. Of these, stage II ROP with an unfavorable type of the process was observed in 11 eyes, stage III – in 3 eyes, posterior aggressive ROP – in 13 eyes, including 9 eyes at the stage of early clinical manifestations and 14 eyes at the manifestation stage.

**Keywords:** posterior aggressive retinopathy of prematurity, laser retinal coagulation, differentiated approach, digital retinal pediatric video system.

**Introduction.** One of the defining modern trends in the treatment of active retinopathy of prematurity (ROP) taking into account the revised indications for laser retinal coagulation (LRC) ETROP is the early implementation of laser treatment, at the "pre-threshold" stage of the disease [3, 6]. The main principle of laser treatment of active ROP is considered to be the adequacy of laser exposure. In the works of foreign authors, much attention is paid to the assessment of the density of coagulate application and the influence of this factor on the effectiveness of treatment. It has been proven that the so-called "confluent" coagulation is more effective than the "scattered" technique of coagulate placement in the treatment of the "threshold" stage of ROP [4, 7]. At the same time, it should be noted that the consequence of high-density coagulation is the formation of gross postcoagulation changes in the form of extensive fields of chorioretinal atrophy (a manifestation of hypercoagulation). In addition, the tendency to increase the number of coagulates and to perform "drain" coagulation entails a longer duration of the laser treatment session, and, consequently, the duration of anesthesia for a premature baby. In this regard, laser coagulation of the retina, coagulants that are applied in a certain sequence according to pre-set templates with a high scanning speed of more than 50 pulses per second, are of particular interest [5, 8]. The purpose of the study is to evaluate the effectiveness of laser treatment of retinopathy of prematurity.

**Material and methods.** The study was conducted on 120 eyes of 60 premature infants (gestation period – 25–31 weeks, birth weight – 670–1630 g, age – 5–8 weeks) with different stages of ROP. Voluntary informed consent for the implementation of therapeutic and diagnostic measures was obtained from all parents. All children underwent a comprehensive diagnostic examination, including indirect binocular ophthalmoscopy, biomicroscopy of the anterior segment of the eye, digital retinoscopy using a wide-field digital retinal pediatric video system "RetCam-3" (Massie Research Laboratories Inc, USA). The interpretation of diagnostic study data was carried out in accordance with

the developed clinical and morphometric classification [2]. All patients were divided into two groups depending on the method of laser coagulation. The main group consisted of 70 eyes of 35 newborns with active ROP, on which we performed optimized laser coagulation of the retina. Of these, stage II ROP with an unfavorable type of the process course was noted in 11 eyes, stage III with an unfavorable type of course - in 3 eyes, posterior aggressive ROP - in 9 eyes, including 35 eyes at the stage of early clinical manifestations, and 12 eyes at the manifestation stage. The control group included 100 eyes of 50 infants, on which only conservative treatment was performed. Of these, stage II ROP with an unfavorable type of the process course was noted in 11 eyes, stage III - in 3 eyes, posterior aggressive ROP - in 13 eyes, including 9 eyes at the stage of early clinical manifestations and 14 eyes at the manifestation stage. In all cases, laser coagulation of the retina was performed transpupillary using the Quad Pediatric Fundus Lens corneal contact lens (Volk, USA), with the child lying on his side, under machine-mask anesthesia (oxygen-air mixture with sevoflurane) on the Fabius anesthesia machine (Dräger Medical AG&Co. KG, Germany). Patterned laser coagulation of the avascular retina was performed according to the differentiated approach we developed [1], based on the stage and form of the disease (classical course of ROP (stages II, III), posterior aggressive ROP in the stage of early clinical manifestations and the manifestation stage), the severity of the course and the degree of vascular activity (unfavorable type of ROP course), as well as the localization of the process (taking into account the total area of the avascular retina). Optimization of the laser coagulation technique depending on the above factors was carried out according to the degree of coagulation intensity (power, exposure, spot diameter); coagulation density (interval between laser applications); types and configuration of the patterns used. The effectiveness of laser interventions was assessed in the postoperative period separately for each stage and form of active ROP according to the signs characterizing the regression of the disease: clinical (reduction, flattening and disappearance of the demarcation ridge, regression of extraretinal fibrovascular proliferation) and morphometric (reduction in the diameter and tortuosity of the main vessels of the posterior pole of the eye (arteries, veins), the diameter of the peripheral retinal vessels, the area of the avascular retina). Observation periods: before LKS, 1, 2 weeks, 1, 3, 6 months after LKS. The mean value (M) and mean error (m) were used to characterize the variation series. The significance level (p) when testing statistical hypotheses was taken to be 0.05.

**Results.** In the early postoperative period up to 3 days, a comparative analysis of the dynamics of morphometric parameters of the central and peripheral retinal vessels was performed, which showed that the reactive syndrome, expressed in a transient increase in the blood filling of the retinal vessels, was less pronounced and stopped faster in the main group after laser coagulation ( $p < 0.05$ ). In the period of 2-4 weeks after the intervention, signs of germination of the terminal retinal vessels between the laser coagulates into the avascular zone towards the serrated line were noted with the restoration of the correct angioarchitecture of the retina by 3-4 weeks after the intervention. At stage III ROP with an unfavorable type of course, 2 weeks after patterned LCS, flattening and thinning of the demarcation ridge, a decrease in the height and volume of extraretinal fibrovascular proliferation, and gradual resorption of retinal hemorrhages were observed. After one month, the demarcation ridge was determined only in individual segments. As the coagulates were pigmented according to the place of their application, a zone of chorioretinal atrophy with non-uniform pigmentation was formed. Further observation of the process indicated continued growth of retinal vessels into the coagulation zone (previously avascular zone) and normalization of morphometric parameters. At the stage of early clinical manifestations of posterior aggressive ROP immediately after laser coagulation of the avascular retina, within 7-10 days after the intervention, with positive dynamics of the process, a significant decrease in vascular activity in the fundus and the severity of ischemic retinal edema, flattening and disappearance of the demarcation ridge (if any), an increase in the vascularized retina zone due to the "growth" of terminal vessels into the coagulation zone were observed. At the stage of manifestation of posterior aggressive ROP with positive dynamics of the process after performing pattern laser coagulation of the avascular retina in the maximum volume, gradual regression of extraretinal proliferation with flattening of the demarcation ridge, decrease in exudation into the vitreous body, resorption of hemorrhages, as well as gradual sprouting of terminal retinal vessels

beyond the ridge between coagulates towards the extreme periphery in the zone of avascular retina subjected to laser coagulation were noted. With regard to the dynamics of morphometric parameters, both in the main and control groups, a statistically significant difference was established between the mean values at different observation periods (1st week - 6 months) within each stage of ROP ( $p = (0.045-0.0001)$ ), which confirms the data of clinical observations indicating a decrease. The analysis of the efficiency of pattern laser coagulation shows that it is not inferior to the standard one, and in terms of the percentage of regression of ROP it surpasses LCS in the single-pulse mode, although this difference is not statistically significant. Thus, the use of the developed differentiated approach to the implementation of dosed laser coagulation of the avascular zone of the retina ensures regression of the disease with an unfavorable type of course of stage II ROP in 100% of cases (in the control - in 100%), with an unfavorable course of stage III ROP - in 96.4% (in the control - in 95.03%), with posterior aggressive ROP at the stage of early clinical manifestations - in 80% (in the control - in 75.6%), at the stage of manifestation - in 61.6% of cases (in the control - in 59.1%). Based on the conducted studies, we have determined the following indications for laser coagulation, namely: stage II ROP with an unfavorable type of course, stage III of an unfavorable type with a classic course of ROP, posterior aggressive retinopathy of prematurity at the stage of early clinical manifestations and manifestations. The main criteria for determining indications are, in addition to the clinical signs characterizing these stages, objective quantitative indicators of the state of the retinal vessels, determined by the method of digital morphometry.

**Discussion.** In our opinion, the differentiated approach to LCS in the treatment of ROP should be as follows. When performing early coagulation, in cases of unfavorable course of stage II, posterior aggressive ROP at the stage of early clinical manifestations or ROP of the 1st zone, it is necessary to use a more gentle, function-saving version of laser coagulation (dosed coagulation with low or moderate intensity and coagulation density). Severe forms of ROP with high vascular activity, confirmed by morphometric parameters of vessels in the center and on the periphery, and an extensive avascular zone require a more aggressive laser coagulation technique in full, with maximum density and high intensity. In our opinion, the identification of objective markers of ROP progression based on the study of morphometric parameters of the main and peripheral retinal vessels and the area of the avascular retina is a rationale for expanding the indications for earlier laser treatment before the development of the III "threshold" stage of the disease. Given the extremely unfavorable prognosis and the lightning speed of the course of posterior aggressive ROP, we believe it is justified to perform early dosed laser treatment in the mode at the stage of early clinical manifestations of this form of the disease. It should also be noted that intensive coagulation with high density at the stage of manifestation of posterior aggressive ROP is inevitably associated with the risk of narrowing of the visual fields in the late period. Therefore, early dosed coagulation optimized by energy parameters and sufficient to achieve complete regression of ROP can not only prevent unfavorable anatomical outcomes, but also help preserve peripheral vision in premature infants with severe forms of ROP. This circumstance emphasizes the exceptional importance of early detection of signs of retinopathy of prematurity progression and laser treatment within the optimal time frame, which is 5-7 weeks for the classic course of the disease and 5-6 weeks for the posterior aggressive form of ROP.

**Conclusions.** The results of the studies convincingly indicate that the effectiveness of laser treatment is determined by three main factors: the initial severity of the disease (the degree of severity of vascular disorders and the localization of the process), the timeliness of the implementation and the adequacy of laser coagulation. The retinal technology we have developed most fully meets the adequacy principle, since it is the most precise dosed, controlled (in terms of energy parameters and coagulation density) and predictable in terms of clinical response effect; provides a significant reduction in the duration of the intervention, achieved by applying a group of coagulates (laser applications) according to a pre-selected template with a high scanning speed, and, consequently, a reduction in the time the premature baby spends under anesthesia; laser coagulation of the required area of the avascular retina is performed in one session, regardless of the localization of the pathological process.

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