

# The Role of the Contribution of Optical Coherence Imaging Studies in Children with the Consequences of Perinatal Hypoxic Central Nervous System Disorder

Niyazov Shukhrat Toshtemirovich<sup>1</sup>, Ergashev Suhrob Sayidovich<sup>2</sup>, Djurabekova Aziza Takhirovna<sup>3</sup>

<sup>1</sup>Doctor of Medical Sciences, Associate Professor, Department of Neurology, Samarkand State Medical University

<sup>2</sup>Basic Doctoral Student of the Neurology Department, Samarkand State Medical University

<sup>3</sup>Doctor of Medical Sciences Professor, Head of the Department of Neurology, Samarkand State Medical University

**Abstract** Perinatal lesions of the central nervous system (PNS) or hypoxic-ischaemic encephalopathy is a group of pathological conditions associated with brain damage in the perinatal period.

**Keywords** Optical coherence imaging, Studies in children, Perinatal hypoxic disorder, Central nervous system

## 1. Introduction

Scientists of modern paediatrics, paediatric neurology, paediatric neurorehabilitation have achieved high successes in the field of medicine dealing with the problem of consequences of perinatal damage of the central nervous system (CNS) in children. The main task of specialists is conditioned by prevention of disability formation from childhood [1,5,9]. Over the last ten years, researchers have argued that the basis of all CNS lesions in children is initially based on a variety of morphofunctional shifts in the brain associated with individual neuroontogenesis [2,6,10]. If we consider all disorders associated with hypoxic CNS disorders as a consequence of perinatal damage, a variety is noted, including delayed motor development up to the formation of cerebral palsy, delayed psycho-speech development, cognitive deficiency, seizure syndromes, hydrocephalus, attention deficit and hyperactivity disorder, visual and auditory deficits, dysythonia [3,7,11]. Literature sources of recent years indicate that the formation involves not only cerebral changes at the level of cells, but also the formation of destructive diffusion in the area of the blood-brain barrier, and this occurs instantly (a few minutes), or in a subsequent stage with slow progression [4,8,12]. This fact leads to the cause of release of neurospecific factors into the blood, which leads to neuro-conflict or pathomechanical triggering of the autoimmune process in the CNS directly related to cell migration, which is important in the formation of the growing and developing brain [13,17]. Given the huge potential of scientific works, the issue of clinical features of the consequences of cerebral ischaemia in the perinatal

period remains controversial, which makes it difficult to determine the true incidence of perinatal encephalopathies. The issues of differentiation criteria and transition from the level of normative indicators to pathological ones have not been fully resolved. Practical experience of doctors shows that it is not uncommon to find severe CNS defects in case of minor abnormalities when collecting anamnesis, and the opposite is true, in case of severe and obvious catamnestic factors, normal development of the child [5,9,11]. All this is due to the fact that mainly the diagnostic value is based on clinical and anamnestic data and traditionally on neurosonographic indicators, which can show only already formed structural disorder, besides it is limited by age [6,10]. Therefore, the issue of finding new criteria for diagnosis and prognosis of brain deficit remains relevant. A promising direction is the study of optical coherence tomography, laboratory indices of pyruvic acid [3,7,15], which is a link in the complex chain of energy exchange of methochondrial structures [8,12].

Thus, perinatal encephalopathy and its consequences remain a controversial problem, the urgency of the problem is not decreasing, but increasing due to the growth of child neurological disability, thus reducing the level of socio-economic development of the country as a whole.

Purpose of the study. To study clinical manifestations of the consequences of perinatal hypoxic encephalopathy in children, with the estimation of the contribution of optical-coherent imaging of the central nervous system lesions.

## 2. Material and Methods of Research

There were 40 children aged from 1 to 2 years with the consequences of perinatal hypoxic-ischaemic encephalopathy (main group) under observation. 16 children from them were

observed in dynamics from the moment of the newborn period. A separate questionnaire was administered to the mothers of the main group, where the anamnesis of somatic status before pregnancy, obstetric and gynaecological status during pregnancy and the outcome of delivery were carefully studied. The comparison group consisted of 20 healthy children of identical age (1-2 years). All patients underwent standard traditional examination by a neurologist, neonatologist, paediatrician, and ophthalmologist. Additional examination combined laboratory methods (blood biochemistry, urinalysis); all children underwent neurosonographic examination (but the indicators are not included in the description of this article, given the purpose of the study). Quantitative scales, included the study of levels of psycho-speech behaviour. This work was carried out on the basis of the paediatric neurological department and neonatal pathology department of MK Samarkand State Medical University (Samarkand), for the period 2022-2024.

As noted above, retinal OCT was performed in 11 children with perinatal encephalopathy at the age of 6-12 months, who constituted group A. At the same time, 5 patients underwent OCT at an earlier date, respectively, in the dynamics of the examination, where the age from birth was 7-8 weeks. The control group consisted of children of corresponding identical age, healthy, 10 children, who constituted group B. For the examination, parents signed a written voluntary consent for the medical study. The examination was performed on the Cirrus TM. HD-OCT SPECTRAL DOMAIN TECHNOLOGY, Carl Zeiss AG (Zeiss) Germany, where the area and perimeter, retinal thickness, densities of superficial and deep plexus vascular, presence or absence of neovascular complexes were determined. As confirmation of the obtained results, it was necessary to clearly fix the patient in the lateral position, where the results corresponded to the rotation of the obtained images by 90 degrees. It should be noted that the age peculiarity required a quick procedure, in this connection only a high quality image of one eye was taken, and the analysed eye was chosen randomly. Statistical processing of the material was performed on an individual computer, where clinical parameters and quantitative scales were analysed by the traditional method of Spearman's criterion, and OCT parameters, as they have no normative separation, were studied in comparison groups according to the Mann-Whitney (U) criterion, where differences with values  $p < 0.05$  were considered reliable.

### 3. Result of the Study

In accordance with the objective, the study included observation of children with perinatal encephalopathy of hypoxic-ischaemic genesis of different severity using a set of planned clinical and instrumental studies. An important component in the pathology of PEP, is the level of maternal health, the peculiarity of the course of the entire period of pregnancy, childbirth, the impact on the birth of a child with

various deviations of organs and systems, which forms in them, in the future, certain functional-organic disorders. Accordingly, the analysis of extragenital changes and the course of antenatal time in mothers is undoubtedly indicative of the examined children. Thus, the result of the analysis showed that among the complications of pregnancy in mothers of the examined children there are many aggravating factors, such as placental insufficiency and chronic intrauterine fetal hypoxia, directly affecting the nature of neurological pathology in children.

**Table 1.** Level of somatic health, pregnancy course, and birth outcomes of mothers of children with PEP by severity level (%)

Indicators	Main group (n=40)	
	I-II degrees (n=20)	II-III degrees (n=20)
I. Extragenital:		
Maternal pathology	10	29
Thyroid problems	15	12
Chronic ENT diseases	6	16
Chronic pyelonephritis	4	21
Acute respiratory viral infections, influenza, COVID-19 during pregnancy	12	36
Varicose veins of the lower limbs	3	7
Endometriosis	6	25
Anaemia	100	100
Gestosis of pregnant women	4	18
Threat of termination	13	35
polyuria	10	12
Fetal hypoxia	100	100
Placental abruption	2	10
Pelvic presentation	0	3
Symptom of overpregnancy	0	4
Delayed foetal development	3	8
Weakness of labour	14	30
Rapid and impetuous labour	18	28
Untimely discharge of amniotic fluid	13	25,6
Caesarean section	7	23
Large foetus	3	11
Umbilical cord entanglement	20	40

In addition, the high frequency of manifestations of extragenital problems in mothers of children with PET, in the pathomechanism plays the role of antenatal inclusion of autoimmune processes leading to the formation of neurological deficits. The difficulty in making the diagnosis and subsequent prognosis, lies in the particular polymorphism of symptoms and syndromes. In addition, as indicated by literature sources, often when initially diagnosed with a medium severity degree, most children show significant recovery of brain activity, and vice versa, a mild degree, poorly correctable and accompanied by the formation of neurological disorders.

**Table 2.** Clinical and neurological symptoms in children with PEP sequelae

Indicators	Main group (n=40)	
	I-II degrees (n=20)	I-II degrees (n=20)
	%	%
Pyramidal disorders	1,5	36
Seizure syndrome or predisposition	0	30
Agitation or hyperactivity syndrome	50	78
Signs of vegetovisceral dysfunction	60	80
Delayed psycho-speech development	40	50
Age-appropriate psycho-motor and speech development	54,3	4,9

In addition, the study showed that as children grow older, the manifestation of neurological defects becomes more pronounced and, accordingly, the number of children with organic cerebral disorders increases. Neurological disorders in the form of psycho-motor and speech development are mostly observed in children with PEP of I-II degree. Whereas, in children with PEP of II-III degree of severity, disorders in the form of stato-motor changes with the corresponding degree of severity are traced, where the reliability of comparison is equal to  $p < 0,05$ .

The use of quantitative scales to assess muscle-postural changes in tone, reflexes and psycho-motor development allows us to objectively evaluate minor and minimally expressed deviations in the neurological status of children with PEP of different severity levels.

However, clinical signs and quantitative scales do not fully allow assessing the current outcome of neurological deficit in one-year-old children, which creates the need to search for and study the parameter of additional examination of children to determine the pathomechanism of cerebral pathology, the severity and prognosis of various outcomes of perinatal hypoxic-ischaemic lesions of the CNS, with subsequent optimisation of therapy and rehabilitation. In this connection, the children underwent a dynamic study of cerebral structures depending on the severity of PEEP by optical coherence imaging. Optical coherence tomography

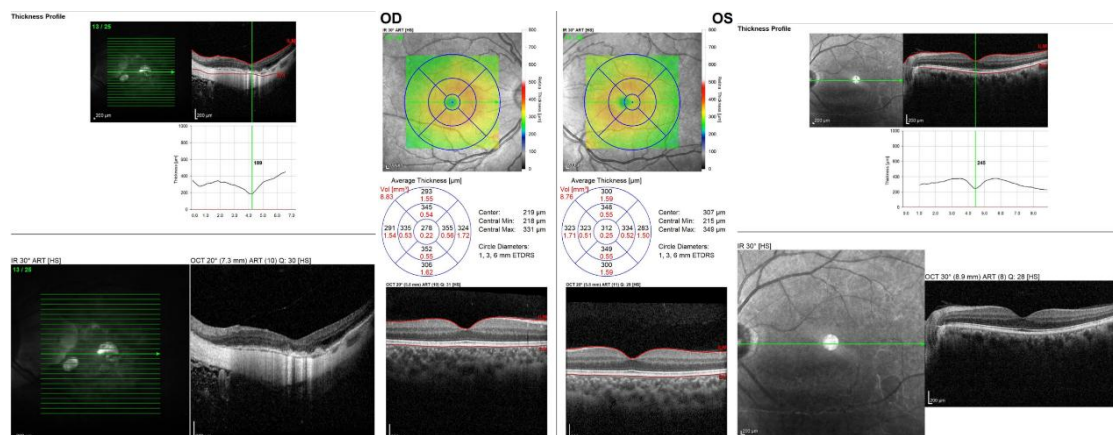
OCT is nowadays considered to be a high-tech imaging method allowing to study the vascular network of the retina and chorioidea in different perspectives, using the method of tracking the characteristic movement of blood elements along the vessels.

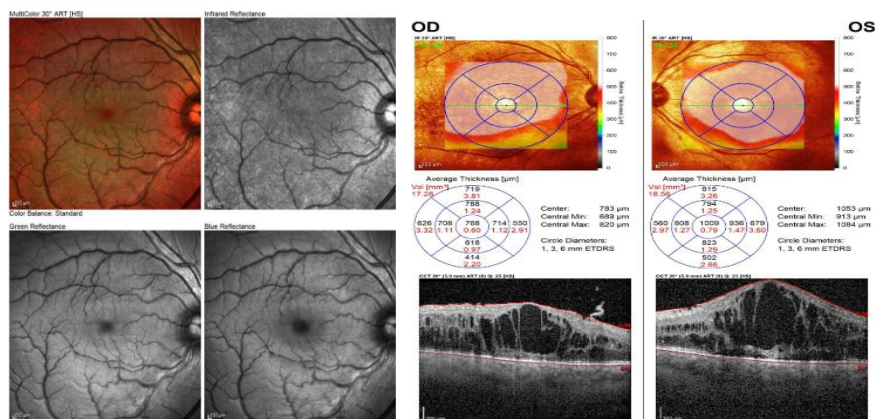
**Table 3.** Quantitative scale (according to Beili) in children with PEP sequelae

Indicators	Main group (n=40)	
	I-II degrees (n=20)	I-II degrees (n=20)
	%	%
-Severe developmental delay	31	60
-moderate developmental delay	30	8
-optimal development	30	3
-accelerated development	2	0
- motor impairment	1,5	27
-explicit developmental delay	6	63
-moderate developmental delay	32	5
-optimal development	50	4
-accelerated development	2	0

OCT images show signs of retinal immaturity, persistence of inner layers, reduction of the thickness of the outer layer of the retina equal to  $239 \pm 12$  microns. The borders of intermittent compression of the inner boundary membrane and unequal increase of the mechanical layer of the retina due to ischaemic oedema are revealed. The images show multiple local boundaries on the side of the inner retinal layer, some of which stand out above the retinal surface (Fig. 1).

In the figures of 7 patients, the zones of vascularisation are visible, the borders of epiretinal proliferation, with an average size of  $36 \mu\text{m}$  with narrowing at the base, are displayed close to the retinal border, which suggests early involvement of the vitreous body in the pathological process of the disease. In a comparative aspect, between groups A and B, the capillary density structure in the deep vascular bundle was larger than in the superficial vascular plexus ( $39.9 \pm 1.6$  and  $50 \pm 1.7$ , respectively) and statistically significantly higher in patients with hypoxic-ischaemic encephalopathy, where  $p < 0.001$ .

**Figure 1.** 7 patients, zones of vascularisation are visible, borders of epiretinal proliferation, with an average size of  $36 \mu\text{m}$  with narrowing at the base, are displayed close to the retinal border



**Figure 2.** In the examined children (11 patients), at the same time in the dynamics (5 patients), signs of proliferation were revealed in the form of areas of retinal zone enlargement, with a characteristic size of a rather high zone, up to 300 µm

In the examined children (11 patients), at the same time in the dynamics (5 patients), signs of proliferation were revealed in the form of areas of retinal zone enlargement, with a characteristic size of a rather high zone, up to 300 µm. This indicates serious significant lesions of the retinal structure in children with clinical manifestations of PEEP on the background of hypoxic ischaemia of the CNS. However, tracing in the dynamics of 5 patients, a tendency to improvement (possibly on the background of treatment) should be noted (*Fig. 2*).

## 4. Conclusions

The main problem in neonatal hypoxic ischaemic encephalopathy is early differential diagnosis, prognosis and classification of the disease, on the results of which the further optimisation of treatment directly depends. The study revealed a direct significant dependence of maternal health before and during pregnancy, quality of labour and complications on the outcome of birth, dependence on the time of the beginning of procedures to compensate for the resulting hypoxia. In recent advances in systemic diagnostics, the use of optical coherence tomography makes it possible to study at an early stage the differentiation and prognosis of children with PEP. As an addition to clinical signs, as well as establishing the relationship with the degree of severity of PEP, especially this fact is necessary taking into account the detection of brain damage in newborns, because it is in the first days of life is difficult to diagnose the impact of hypoxia on the whole organism. The determination of tracing in the dynamics of existing signs of brain damage to clarify not only the diagnosis of PEP (complications), but also to prescribe the correct treatment without polyprognostism is of interest in this direction.

## REFERENCES

- [1] Koehler RC, Yang Z-J, Lee JK, Martin LJ. Perinatal hypoxic-ischemic brain injury in large animal models:

Relevance to human neonatal encephalopathy. // *Journal of Cerebral Blood Flow & Metabolism*. 2018; 38(12): 2092-2111. doi:10.1177/0271678X18797328.

- [2] Cornet M.C., Kuzniewicz M., Scheffler A., Forquer H., Hamilton E., Newman T.B., Wu Y.W. Perinatal Hypoxic-Ischemic Encephalopathy: Incidence Over Time Within a Modern US Birth Cohort. // *Pediatric neurology*, (2023). 149, 145–150.
- [3] Lee B.R., Class H.C. Cognitive outcomes in late childhood and adolescence of neonatal hypoxic-ischemic encephalopathy. // *Clinical and Experimental Pediatrics* 2021; 64 (12), p. 608-18.
- [4] Munsant A, Shrivastava K, Recasens M and Giménez-Llort L Severe Perinatal Hypoxic-Ischemic Brain Injury Induces Long-Term Sensorimotor Deficits, Anxiety-Like Behaviors and Cognitive Impairment in a Sex-, Age- and Task-Selective Manner in C57BL/6 Mice but Can Be Modulated by Neonatal Handling. // *Front. Behav. Neurosci.* 2019, №13, 7. doi: 10.3389/fnbeh.2019.00007.
- [5] Molloy, E.J., Branagan, A., Hurley, T. *et al.* Neonatal encephalopathy and hypoxic-ischemic encephalopathy: moving from controversy to consensus definitions and subclassification. // *Pediatr Res* 94, 2023, 1860–1863.
- [6] González de Dios, J., & Moya, M. (1996). Asfixia perinatal, encefalopatía hipóxica-iscémica y secuelas neurológicas en recién nacidos a término: estudio epidemiológico (I) [Perinatal asphyxia, hypoxic-ischemic encephalopathy and neurological sequelae in full-term newborns: an epidemiological study (1)]. // *Revista de neurologia*, 24(131), 812–819.
- [7] Perinatal asphyxia and hypoxic-ischemic encephalopathy // <https://www.amboss.com/us/knowledge/perinatal-asphyxia-and-hypoxic-ischemic-encephalopathy>.
- [8] Santina A Zanelli Hypoxic-Ischemic Encephalopathy // 2018.
- [9] Baker, J., Safarzadeh, M. A., Incognito, A. V., Jendzjowsky, N. G., Foster, G. E., Bird, J. D., Raj, S. R., Day, T. A., Rickards, C. A., Zubieta-DeUrioste, N., Alim, U., & Wilson, R. J. A. Functional optical coherence tomography at altitude: retinal microvascular perfusion and retinal thickness at 3,800 meters. // *Journal of applied physiology* (Bethesda, Md.: 1985), 2022. № 133(3), p. 534–545.
- [10] Abbas Al-Hawasi Retinal ganglion cell examination with Optical Coherence Tomography reflects physiological and pathological changes in the eye and the brain. // Ali Bin Abi-Talib,

2023, 100 p., DOI:10.3384/9789180754194.

- [11] Cappellini G, Sylos-Labini F, Dewolf AH, Solopova IA, Morelli D, Lacquaniti F and Ivanenko Y (2020) Maturation of the Locomotor Circuitry in Children With Cerebral Palsy. *Front. Bioeng. Biotechnol.* 8:998. doi: 10.3389/fbioe.2020.00998.
- [12] Weinstein J.M., Gilmore R.O., Shaikh S.M., Kunselman A.R., Trescher W.V., Tashima L.M., Boltz M.E., McAuliffe M.B., Cheung A., & Fesi, J.D. Defective motion processing in children with cerebral visual impairment due to periventricular white matter damage. // *Developmental medicine and child neurology*, 2012. №54(7), e1–e8.
- [13] Grego, L., Pignatto, S., Busolini, E., Rassu, N., Samassa, F., Prosperi, R., Pittini, C., Cattarossi, L., & Lanzetta, P. Spectral-domain OCT changes in retina and optic nerve in children with hypoxic-ischaemic encephalopathy. // *Graefe's archive for clinical and experimental ophthalmology = Albrecht von Graefes Archiv fur klinische und experimentelle Ophthalmologie*, 2021. № 259 (5), p. 1343–1355.
- [14] Клиточенко Г.В., Малюжинская Н.В. Этиология, патогенез и диагностика перинатального поражения нервной системы у детей // *Лекарственный вестник*, 2019. Том 13, № 1 (73). с. 38-41.
- [15] Ergashev Sukhrob Saidovich Niyazov Shukhrat Toshtemirovich, Jurabekova Aziza Takhirovna Clinical and Neurophysiological Features of Children Born Prematurely // *American Journal of Medicine and Medical Sciences*, 2023; № 13(5): p. 612-615.