European International Journal of Multidisciplinary Research and Management Studies

TYPE Original Research
PAGE NO. 138-142
DOI 10.55640/eijmrms-05-01-32

Check for updates

Characterization of Cerebral Hemodynamics in Newborns with A History of Chronic Hypoxia

Ziyadullaeva H.

Samarkand State Medical University, Uzbekistan

Hudoyorova I.

Samarkand State Medical University, Uzbekistan

Kurbonova A.

Samarkand State Medical University, Uzbekistan

Ganiev B.

Samarkand State Medical University, Uzbekistan

OPEN ACCESS

SUBMITTED 24 October 2024
ACCEPTED 26 December 2024
PUBLISHED 30 January 2025
VOLUME Vol.05 Issue01 2025

Abstract: Aim and Context: The aim of this study is to investigate the impact of chronic intrauterine hypoxia on cerebrovascular pathology in newborns. This is an important topic because hypoxia (a lack of oxygen) in the womb can have a significant effect on the development of the brain and the central nervous system of the child.

Study of Endothelial Dysfunction Markers: The author conducted research on the levels of endothelin-1 in the blood of newborns. Endothelin-1 is a biologically active substance produced by vascular endothelial cells. Elevated levels of this marker may indicate vascular endothelial damage or dysfunction.

Study of Hemostasis Parameters: Hemostasis is the process of controlling bleeding, and in the article, the author also investigated several hemostatic parameters, including the level of fibrinogen, which is an important factor in the blood clotting process.

Results: The levels of fibrinogen and endothelin-1 were found to be elevated in newborns who experienced chronic intrauterine hypoxia. This may indicate disturbances in the blood clotting system and vascular endothelial function. Elevated levels of endothelin-1 can also affect cerebral hemodynamics, i.e., the blood

supply to the brain.

Conclusion: The study highlights the importance of researching cerebrovascular pathology and endothelial dysfunction markers in newborns, especially those who experienced hypoxia before or during childbirth. This helps understand the biochemical changes associated with this pathology and what precautionary measures or treatments can be applied.

Keywords: Hypoxia, hemostasis, endothelin-1, fibrinogen, cerebral blood flow velocity, resistance index.

Introduction: Frequency of perinatal hypoxia is not decreasing. 60-80% of all central nervous system (CNS) diseases in children are associated with perinatal hypoxia [1,2].

In the development of chronic intrauterine fetal hypoxia, transitioning to neonatal hypoxia, three main groups of causes are identified:

1. Maternal extragenital diseases - thyroid diseases, bronchial asthma, anemia, heart rhythm disorders, smoking, neurocirculatory dystonia, obesity, diabetes.

2. Disorders of uteroplacental circulation (maternal hypertension or arterial hypotension).

3. Disturbances of fetal-placental circulation (tight coiling of the umbilical cord around the neck, body, true knots of the umbilical cord, and placental abruption) [2].

One of the main causes of hemorrhagic and ischemic brain damage in newborns is disorders of cerebral hemodynamics [5]. Hypoxia is recognized as a leading etiological factor in particular cerebrovascular disorders, leading to the development of hemorrhagic and ischemic damage to the central nervous system (CNS) in newborns [4].

One of the most important factors leading to structural brain damage is a disturbance in cerebral blood flow against the background of hypoxia. Hemodynamic changes that occur during an unfavorable perinatal period and are related to the impairment of cerebral blood flow autoregulation contribute to the development of hemorrhagic complications and subsequent destructive changes in brain tissue. Effective hemodynamic support depends on the tone of cerebral vessels. According to recent studies, a healthy full-term newborn is born with a high resistance index (RI), which quickly decreases by the end of the first day of life and stabilizes by the end of the early neonatal period (RI - 0.69-0.73) [8].

For healthy newborns in the first day (especially the first hours) of life, a thrombogenic tendency in hemostasis is characteristic, which changes to a tendency for hypocoagulation and hypoaggregation on the 3rd to 4th day of life. In children with asphyxia, this tendency is more pronounced. However, in cases of severe asphyxia, there is a significant increase in the blood's coagulation potential [9].

Elevated endothelin-1 (ET-1) has been observed in umbilical cord blood in newborns with hypoxic brain damage [2,7]. The primary mechanism of action of ET involves the activation of calcium release, leading to:

1. Stimulation of platelet adhesion and aggregation and secondary hemostasis.

2. Contraction and growth of vascular smooth muscle, leading to vessel wall thickening and vasoconstriction [2,10].

A significant increase in the levels of ET-1 in the blood, along with a significant decrease in endothelial nitric oxide production, indicates a predominance of vasoconstriction over vasodilation in patients who have experienced acute cerebral blood flow disturbances. This results in vasospasm and slowed blood flow [2]. The degree of brain tissue damage directly correlates with the severity of endothelial dysfunction [7,10].

ET-1 influences cerebral autoregulation processes by narrowing cerebral blood vessels and reducing cerebral blood flow below the ischemic threshold, which can trigger cerebral infarction [10]. It has been found that ET-1 initiates cerebral artery spasm as a result of its direct action on the vascular wall and through the depolarization of neurons, which is caused by the activation of endothelin receptors type A and phospholipase C [2,10].

Objectives

The aim of this study was to investigate the state of certain hemostasis parameters, vascular endothelium, and cerebral hemodynamics in newborns who experienced chronic intrauterine hypoxia.

METHODS

Under observation were 59 newborn infants of various gestational ages with perinatal nervous system damage. The subjects were divided into 2 groups: Group I consisted of healthy newborns. Group II comprised 37 newborns who experienced chronic intrauterine hypoxia. Children in this group were diagnosed with CNS damage of severity levels II and III, determined by the duration of the depression syndrome, the presence of neonatal seizures, and the dynamics of structural changes in the brain based on ultrasound examination. In terms of gender distribution, 37% were boys and 63% were girls.

The causes of chronic intrauterine fetal hypoxia were as follows: severe anemia (8%), exacerbation of chronic pyelonephritis (10%), severe preeclampsia (16%), threatened preterm labor (20%), late toxemia (10%), fever (3%), transverse fetal position (5%), ascites and anasarca (17%), in vitro fertilization with multiple pregnancies (3%), oligohydramnios (5%), low placental location (3%) (see Diagram 2).

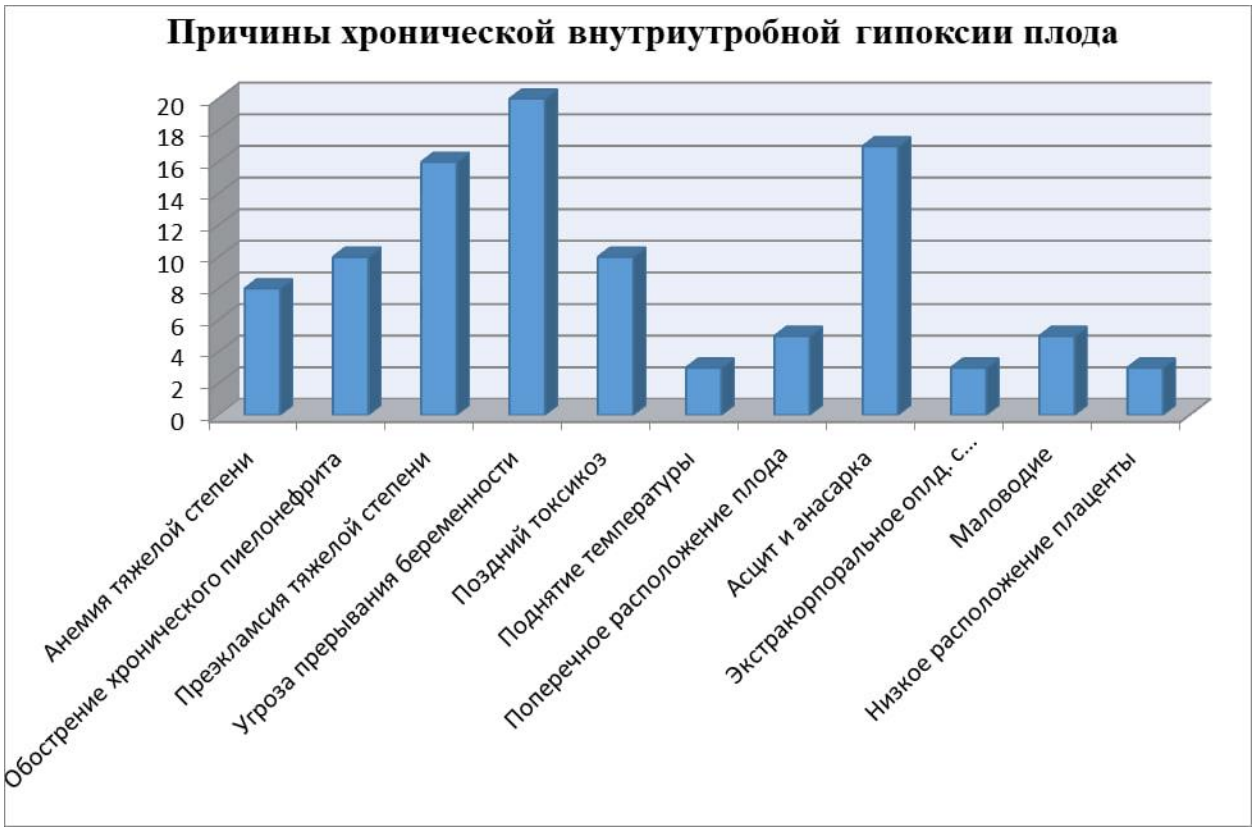

Diagram 1. Causes of chronic intrauterine hypoxia in newborns of Group 2.

The distribution of children in this group by body weight was as follows: ≤ 1000 g - 9%, 1000 - 1499 g - 13%, 1500 - 2499 g - 43%, 2500 - 3999 g - 32%, more than 4000 g - 3%.

The assessment on the Apgar scale at birth for newborns who experienced chronic intrauterine hypoxia was as follows: 0-3 points in 19%, 4-5 points in 52%, 6-7 points in 19%, and 8-10 points in 10%.

The diagnosis of "perinatal encephalopathy" was established according to the classification of perinatal nervous system damage in newborns by Sarnat and Sarnat (1976).

Methods of the research. Laboratory coagulation studies included prothrombin time (PT), prothrombin index by Quick (PI), international normalized ratio (INR), activated partial thromboplastin time (APTT), fibrinogen, and thrombin time (TT) and were determined using the Human clot junior (2000) apparatus. The specific marker of endothelial dysfunction, endothelin-1 in the blood, was determined by an enzyme-linked immunosorbent

assay (ELISA) using the Mindray BS-380 apparatus.

Instrumental studies consisted of ultrasound examination of the brain's structure in B-mode (neurosonography), Doppler ultrasound of the brain's blood vessels using color scanning and spectral Doppler ultrasound, performed on the GE Logic F 8 apparatus (USA) using multi-frequency convex transducers of 5.5 MHz, a linear transducer with a scanning frequency ranging from 7 to 10 MHz. Scanning was performed in standard planes. Spectral Doppler was performed in the anterior cerebral artery (ACA), middle cerebral artery (MCA) on the right and left, and the Galen vein. The resistance index (RI) was assessed in the anterior cerebral artery (ACA), middle cerebral artery (MCA) on the right and left, and blood flow velocities in the Galen vein.

Statistical data analysis was conducted using specialized software, including Statistica 10.0, Microsoft Excel 2017, and SPSS (version 29, IDV Co. Armonk, NY, USA).

RESULTS AND DISCUSSION

In the analysis of the obtained coagulation parameters, such as PT, INR, APTT, and TT, there were changes observed in both healthy and newborns with chronic hypoxia, but these changes did not exhibit statistically

significant differences. For instance, in healthy newborns, PT averaged 14.14 ± 1.02 seconds, while in newborns with chronic hypoxia, it averaged 12.75 ± 0.82 seconds. Similarly, PI was 93.43 ± 6.91% in healthy newborns and 110.15 ± 6.03% in newborns with chronic hypoxia.

However, among the coagulation parameters studied in umbilical cord blood, only the fibrinogen level in newborns with chronic conditions showed a statistically significant difference ($p < 0.01$), increasing to an average of 3.96 ± 0.58 g/L (Table 1).

Table 1

Indicators of the blood coagulation system and vascular endothelium in the examined newborns (M±m).

No	Indicators	Group 1 (n=22)	Group 2 (n=37)
1	PT (sec)	14,14±1,02	12,75±0,82; P>0,2
2	PI (%)	93,43±6,91	110,15±6,03; P>0,1
3	INR	1,35±0,16	1,06±0,08; P >0,1
4	APTT (sec)	39,01±4,80	33,34±1,38; P >0,2
5	TT (sec)	46,43±8,52	48,15±6,59; P >0,5
6	Fibrinogen (g/l)	2,11±0,42	3,96±0,58; P <0,01
7	Endotelin (pg/ml)	0,04±0,001	1,06±0,24; P <0,001

Note: P indicates the significance of differences in parameters between healthy newborns and those who experienced chronic intrauterine hypoxia.

At the same time, in newborns who experienced chronic hypoxia, there was an increase in the level of endothelin-1 to 1.06 ± 0.24 pg/ml, which was statistically significant ($P < 0.001$) compared to the values of the group of healthy newborns.

Table 2

Comparative characteristics of cerebral hemodynamics in examined newborns (M±m).

No	Indicators	Group 1 (n=22)	Group 2 (n=37)	P
1	RI (PMA)	0,680±0,006	0,913±0,04	<0,001
2	RI (CMA) right	0,680±0,006	0,904±0,05	<0,001
3	RI (CMA) left	0,674±0,011	0,89±0,05	<0,001
4	V скорость кровотока(см/сек)	7,128±0,075	3,3±0,12	<0,001

Note: P - indicates the significance of differences between the parameters of healthy newborns and newborns who experienced chronic intrauterine hypoxia.

When studying cerebral hemodynamics using Doppler ultrasound in healthy newborns and those who experienced chronic hypoxia, changes were observed. For instance, in healthy newborns, the RI (Resistance Index) of the anterior cerebral artery (PCA) was 0.680±0.006, whereas in those with chronic hypoxia, it

was 0.913±0.04, with a statistically significant difference (P<0.001). The RI of the middle cerebral artery (MCA) on the right in healthy newborns was 0.680±0.006, while in those with chronic hypoxia, it was 0.904± 0.05 (P≤0.001), and the RI of the left MCA was 0.674±0.011 and 0.89±0.05 in healthy and affected individuals, respectively (P≤0.001). The blood flow velocity in the vein of Galen averaged 7.128±0.075 cm/s in healthy individuals and 3.3±0.12 cm/s in affected individuals, with a statistically significant difference (P≤0.001). (Table 2).

CONCLUSIONS

Thus, the conducted research reveals that in cases of chronic intrauterine fetal hypoxia, there is an increase in Endothelin-1 (ET-1) and fibrinogen levels. These changes are accompanied by a decrease in cerebral hemodynamics, characterized by vasospasm, which leads to the development of severe neurological complications in children.

REFERENCE

Vodolaskaya, T.I. (1994). Khronicheskaya vnytriutrobnaya gipoksia ploda u zhenshchin s privychnym nevynashivaniem beremennosti i antenatalnye kritepii riska razvitiya tserebral'nykh narusheniy u novorozhdennykh. [Chronic intrauterine fetal hypoxia in women with habitual miscarriage and antenatal risk criteria for the development of cerebral disorders in newborns]. (Author's abstract of candidate's thesis). Moscow, Russia: Publisher. (24 p.)

Ziyadullaeva, Kh.O., & Dilmuradova, K.R. (2022). Sostoyanie sistemy gemostaza i endoteliya sosudov pri perinatal'nykh porazheniyakh nervnoy sistemy. [State of the hemostasis system and vascular endothelium in perinatal nervous system disorders]. Problemy Biologii i Meditsiny, 5(139), 315-322.

Kovalev, V.V. (2003). Meditsinskie tekhnologii v okhrane reproduktivnogo zdorov'ya zhenshchiny. [Medical technologies in women's reproductive health care]. Nizhnevartovsk, 139-142.

Panakhova, N.F., Guseynova, S.A., et al. (2013). Patogeneticheskie mekhanizmy narusheniy funktsii gematoentsefalicheskogo bar'era u nedonoshennykh novorozhdennykh s tserebral'noy iskhemie. [Pathogenetic mechanisms of blood-brain barrier dysfunction in preterm infants with cerebral ischemia]. Pediatrics, 92(2), 28-32.

Pavlyukova, E.V., Davydova, I.V., et al. (DOL: 10.15690/pf.vl5i21872). Vozmozhnosti profilaktiki i vosstanovitel'nogo lecheniya posledstviy perinatal'nogo porazheniya tsentral'noy nervnoy sistemy u nedonoshennykh detey. [Opportunities for prevention and rehabilitative treatment of consequences of perinatal central nervous system damage in preterm infants]. Publication Title, 159-167.

Remneva, O.V., Fadeeva, N.I., Fil'chakova, O.N., et al. (2015). Intranal'naya gipoksia ploda: vozmozhnosti diagnostiki, rezervy snizheniya chastoty tserebral'nykh rasstroystv u donoshennykh novorozhdennykh. [Intranatal fetal hypoxia: diagnostic possibilities, reserves for reducing the frequency of cerebral disorders in full-term newborns]. Rossiyskiy Vestnik Perinatologii i Pediatrii, 5, 61-65.

Stepanova, Yu.I., & Gonchar, I.A. (2013). Endotelin-zavisimye effekty pri tserebrovaskulyarnoy patologii iskhemicheskogo geneza. [Endothelin-dependent effects in cerebrovascular pathology of ischemic origin]. Meditsinские Novosti, 10, 12-18.

Tumaeva, T.S., Ryazina, I.Yu., Konakova, E.E., Blokhina, Yu.R. (2016). Tserebral'naya gemodinamika u detey gruppy vysokogo riska v neonatal'nom periode. [Cerebral hemodynamics in children at high risk in the neonatal period]. Rossiyskiy Vestnik Perinatologii i Pediatrii, 2, 44 p.

Khotamova, M.N., & Aminov, Kh.D. (2012). Perinatal'nye porazheniya tsentral'noy nervnoy sistemy u novorozhdennykh. [Perinatal central nervous system injuries in newborns]. Vestnik Avitsenny, 117, 70 p.

Gargus, R.A., Vohr, B.R., et al. (2009). Unimpaired outcomes for extremely low birth weight infants at 18 to 22 months. Pediatrics, 124(1), 112-121. DOI: 10.1542./peds.2008-2742.