

Other factors that influence outcome are IUGR, pre-existing brain pathology and brain malformations, frequency and severity of seizures.^[1]

Clinical image

- We evaluate clinical symptomatology according to classification schemes - most often Sarnat and Sarnatová or Levene et al.^[2]

Sarnat staging

I. grade (mild HIE)

- Hyperexcitability, hyperreflexia, hypertonia, prolonged wakefulness, pupil normal, possibly mydriasis, Moro with low equipment threshold, no convulsions present.
- Prognosis: symptomatology resolves within 1-3 days, ICU monitoring is appropriate, but most children do not require further neurological monitoring.^[2]

II. grade (moderately severe HIE)

- Reduced reflexes (sucking, grasping, Moro), hypotonia, lethargy, apathy alternates with irritability, reduced spontaneous movement, or pathological movements: "pedalling" = pedaling a bicycle, "boxing" = boxing, thumbs clenched into fists, bradycardia, central apnea, suction disorders, miosis, subtle convulsions. Prognosis: symptoms usually appear immediately after birth, last for 3-7 days, ICU monitoring is appropriate, 15-30% of children have long-term consequences, usually children where the initial symptomatology persists for more than 1 week.^[2]

III. grade (severe HIE)

- Stupor or coma, gradual development of decerebrate rigidity, minimal spontaneous mobility, absence of reactions to nociceptive stimulus, hyporeflexia/areflexia, areactive pupils, central apnea, convulsions difficult to control pharmacologically.
- Prognosis: in the first 12 hours there is a slight improvement in consciousness, but this is followed by further deterioration up to brain death, 50% of newborns have permanent effects, 50% of newborns die.^[2]

Clinical degrees of perinatal hypoxic-ischemic brain damage according to Sarnat staging^[1]

	Grade I	Grade II	Grade III
State of consciousness	irritant	lethargic or numb	stuporous
Neuromuscular control			
Muscle tone	normal	mild hypotonia	significant hypotonia
Posture	slight distal flexion	significant distal flexion	intermittent decerebration
Tendon-muscular (tension) reflexes	increased	increased	reduced or disappeared
Segmental myoclonus	present	present	missing
More complex (complex) reflexes			
Sucking reflex	weak	reduced or disappeared	missing
Moro's	strong; low threshold	weak; incomplete; high threshold	missing
Oculovestibular	normal	increased	reduced or disappeared
Tonic nuchal	weak	strong	missing
Autonomous function	generalized sympathetic	generalized parasympathetic	both systems reduced
Pupils	mydriasis	miosis	changeable; often unequal; poor reaction to light
Heart action	tachycardia	bradycardia	changeable

Diagnostics - imaging methods and other examinations

- magnetic resonance imaging of the brain - suitable for diagnosis, monitoring the development of the disability and determining the prognosis;
- brain ultrasound - lower sensitivity;
- electroencephalography - to assess the extent of the impairment and diagnosis of subclinical convulsions;
- hearing and vision examination.^[1]

Pathological anatomy

The clinical-pathological picture depends on the severity of the insult, the time elapsed since the insult and whether the brain was affected by simple asphyxia or a combination of asphyxia and ischemia.

- asphyxia → brain edema, selective neuronal necrosis, subcortical gray matter lesions;
- asphyxia + ischemia → "watershed" ischemia (periventricular leukomalacia - cortical and subcortical leukomalacia), focal ischemia (focal lesions in the basin of the a. cerebri anterior, a. cerebri media and parasagittal lesions).^[2]

Hypoxic-ischemic damage to the cerebral cortex – *locus minoris resistentiae*:

- lower parts of sulci;
- III. – V. layer.^[3]

Hypoxic-ischemic damage of white matter – *periventricular locus minoris resistentiae*:

- mild regression (edema, swelling of astrocytes);
- partial necrosis;
- complete necrosis (leukomalacia).^[3]

Late consequences of hypoxic-ischemic encephalopathy:

- minimal brain lesions;
- cortical dysgenesis;
- ulegyria (originally normally formed convolutions, which were secondarily irregularly bent and narrowed; convolutions are rigid, extinct neurons have been replaced by glia);
- pseudocysts – multifocal cystic encephalopathy (cortex and white matter are permeated by a number of cavities separated by gliofibrous septa);
- status mramoratus (marbled and reduced striatum or thalamus; arises as a result of neuronal loss, gliosis and hypermyelination).^{[3][4]}

Therapy

- Comprehensive measures as in asphyxia/hypoxia: ensure ventilation and perfusion with timely cardiopulmonary resuscitation, stabilization of the patient, minimal handling of the patient.^[2]
- Treatment of all organ failures – circulatory, ventilation, kidney, liver and coagulopathy.
- Maintaining the balance of the internal environment (normoglycemia, normocalcemia).
- Treatment of convulsions.
- Thermal management.
- Controlled hypothermia – start within 6 hours of insult, body temperature maintained at $34 \pm 0.5^\circ\text{C}$ for 72 hours.

Prognosis

Sources

Related articles

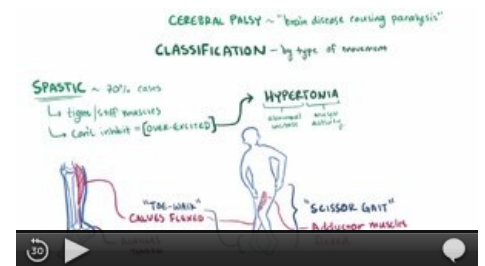
- Cardiopulmonary resuscitation of the newborn
- Neonatal hypoxia
- Diagnosis of fetal condition during pregnancy and delivery • Intrapartum fetal monitoring • Fetal hypoxia

External links

- Doporučený postup ČNeoS (2019): ŘÍZENÁ HYPOTERMIE V LÉČBĚ HYPOXICKÉ – ISCHEMICKÉ ENCEFALOPATIE (<http://www.neonatology.cz/upload/www.neonatology.cz/Legislativa/Postupy/hie-a-rizena-hypotermie-revize-doporuceneho-postupu-27052019.pdf>)

References

1. ZANELLI, Santina A. *Hypoxic-Ischemic Encephalopathy* [online]. The last revision 2011-12-15, [cit. 2012-04-30]. <<https://emedicine.medscape.com/article/973501-overview>>.
2. HAVRÁNEK, Jiří: *Asfyxie x HIE*.
3. Patologicko-anatomický ústav FN Brno - LF MU. *Hypoxicko-ischemická encefalopatie novorozenců* [online]. [cit. 2012-05-01]. <<http://www.med.muni.cz/patanat/encefalopatie.html>>.
4. Ústav patologie, Masarykova univerzita v Brně. *Patologie novorozence : Hypoxicko-ischemická encefalopatie (HIE)* [online]. [cit. 2012-05-01]. <https://atlases.muni.cz/atlas/novo/atl_cz/main+novorozenec+novorasfyxcas.html>.



Cerebral palsy (video).