

Head injury (paediatrics)

Pathophysiology

In healthy individuals, brain perfusion is kept constant by the autoregulation mechanism at MAP (mean arterial pressure) 40–150 torr. Autoregulation involves mechanical factors – CPP, vegetative nervous system, chemical influences – pO_2 a pCO_2 , mediators, body temperature. In trauma there is often a **failure of autoregulation** with a subsequent increase/decrease in cerebral blood flow depending on MAP => the patient is thus at risk of **cerebral hypoperfusion/hyperemia**.

CNS tissue damage occurs in two stages:

- *primary lesion* – direct damage to the parenchyma or vessels of the CNS by the injury mechanism → contusions, haematomas, fractures
- *secondary lesions* – subsequent damage to still healthy CNS tissue, applied here → hypoxia, intracranial hypertension, arterial hypotension, loss of autoregulation of cerebral perfusion, reperfusion

Minor head injury

- head injury at GCS 13–15 points
- the definition is not unambiguous
- head injury in childhood is one of the most common injuries, in a group of young children (especially infants) it often leads to hospitalization
- the reason for hospitalization is the fear of a possible complication of intracranial bleeding
- intracranial bleeding is not often a complication of light head injuries, it is much more common chronic subdural bleeding, especially in infants and young children
- currently, general recommendations for the examination and follow-up of children with mild head injuries cannot be found in the available literature
- there is no clear recommendation as to which imaging method to prefer (USG, X-ray or CT)
- most authors favor **preventive observational hospitalization** for at least **24 hours** and very strict criteria are set so that the child does not have to be hospitalized → then a brain CT should be performed for every child
- there is no uniformity even in the indication of X-ray to exclude or confirm linear skull fracture → the absence of a fissure does not exclude the development of later bleeding, but the presence of a fissure is a serious warning of this possible complication
- a routine CT brain examination is generally **not recommended** and this examination should in no case replace an X-ray image → CT scan should be the examination of choice only in children with suspected intracranial hemorrhage
- the disadvantage of a CT scan is, on the one hand, the high radiation exposure and the need to sedate child → the effect of sedation, including sleep after the procedure, abnormal behavior or vomiting as complications of sedation can complicate further clinical follow-up of children => CT examination should always be properly considered
- in infants and toddlers with an open large fontanelle, a sonographic examination can be performed → the advantage is the absence of radiation and the possibility of repeated examination, i.e. the possibility of monitoring the dynamics of the injury, the disadvantage is the difficult detection of epidural bleeding, which is often located parietal, and the sonography can be unreliable in this place
- regular blood count checks should be a matter of course for all infants, even with a slight injury to the head

a light head injury excludes the presence of clinical signs of impaired consciousness, pathological neurological findings or visible severe injuries of the skin or bony cover

- the severity of the injury is different → we often see infants with only anamnestic evidence of a fall on their head, when we find no signs of injury

Comotio cerebri (Traumatic brain injury)

- reversible, predominantly diffuse impairment

Clinical picture

- unconsciousness → usually short, immediately following the trauma, varying degrees of retrograde amnesia, early-onset headaches, nausea and vomiting
- in the neurological picture, we detect either normal neurological findings or symptoms of the so-called central vestibular syndrom, minor differences in reflexes



Therapy

- rest!!!
- suppression of headaches, vomiting and vertigo

 For more information see *Brain contusions and lacerations*.

Contusio cerebri

- structural changes of the CNS, which may already be irreversible
- impaired consciousness and neurological symptomatology
- observation in the surgical ICU with the possibility of CT, EEG and especially monitoring of intracranial pressure, CNS blood flow and blood saturation in the jugular bulb

CNS bleeding

Subarachnoid bleeding

- as post-traumatic it can complicate any type of craniocerebral trauma or it is bleeding from a vascular malformation

Clinical picture

- meningeal syndrome, severe headaches

Diagnostics

- Lumbar puncture → admixture of fresh erythrocytes in the cerebrospinal fluid
- CT scan

Therapy

- neurosurgical care

Compression bleeding

1. subdural
2. epidural

- threaten the individual's life by increasing pressure on the brain tissue, or brain stem
- it is typical for infancy that clinical signs may be completely non-specific or minimal at first
- many authors mention progressive severe anemia as the leading symptom of intracranial bleeding in the youngest children

A normal finding on the Head radiograph does not rule out intracranial bleeding.

Epidural bleeding

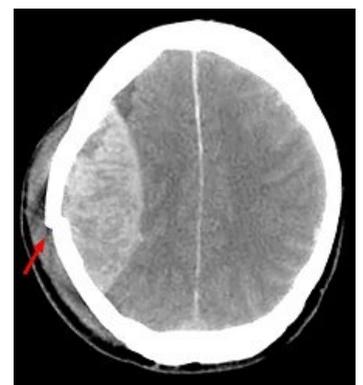
Mostly after trauma from the medial meningeal artery, it spreads between the dura mater and the bony calva.

- this type of bleeding is rare in the infant group and rare in newborns
- the cause of bleeding can also be bleeding from venous shunts, venous connections, fissura lbi, and often the source of bleeding cannot be identified
- the most common localization in infancy is the parieto-occipital region, with decreasing frequency the posterior fossa, frontal and temporal regions are affected

Clinical picture

- unconsciousness immediately after the injury, usually for a shorter period of time
- there can be a lucid interval = immediately after the injury the patient is without symptoms or only with signs of coma, after a certain interval somnolence, impaired consciousness → unconsciousness, coma
- in young children and infants, the lucid interval is rather the exception

Epidural bleeding can be completely asymptomatic at first, with normal neurological and eye findings (the reason for the delayed development of clinical symptoms can be the slower development of epidural bleeding other than arterial origin, but also the drainage of the bleeding in an extracranial direction into the subperiosteal space). It rarely happens that epidural bleeding drains through the cranial fissure into the subperiosteal space (=extracranially) => the symptoms of intracranial hypertension are minimized, which would otherwise lead to an earlier diagnosis of intracranial bleeding Severe progressive anemia, changes in the quality of life can alert us to the possibility of



Epidural Haematoma

epidural bleeding consciousness, external head injury, finding of a fissure on X-ray of the Head. The first of the diagnostic symptoms, but **CAVE!** – already very late!!! – is the expansion of the pupil to mydriasis, typically on the side of the hematoma with contralateral limb deficit = hemiparesis

- atypical clinic
 - there is no unconsciousness at the beginning, it develops only after an episode of headaches
 - unconsciousness initially and continuously further deepening

CT dominates the **diagnosis** !!and from the point of view of **therapy** early surgical intervention is key.

 For more information see Epidural hematoma.

Subdural Hematoma (acute x chronic)

Bleeding between the dura mater and the arachnoid, most often from bridging vessels.

- the result of direct x indirect (shaking trauma, whiplash) trauma
- the symptomatology is similar to epidural bleeding, but the development is often slower => therefore there is more time for a more detailed examination
- lucid interval is more common
- CT is again used in diagnosis

 For more information see Subdural hematoma.

Spinal cord trauma

In diagnosis, MRI takes precedence here. As part of the therapy, methylprednisolone is administered prophylactically in a dose of 30 mg/kg even during the 1st hour, followed by 5.4 mg/kg/hour. during the next 23 hours.

Recommended procedure in the treatment of children with severe craniocerebral injury (SCI)

- In pre-hospital care, intubation, provision of access to the venous bed, sufficient oxygenation and efforts to quickly stabilize circulation are already indicated for severe CCP.
- The treatment of a child with a severe craniocerebral injury must be carried out in a specialized department of pediatric intensive care and resuscitation with the possibility of neurosurgical intervention.
- When admitted to the hospital, provision of access to the central venous and arterial river is indicated.
- The initial examination should include an examination by a pediatric neurologist, therefore it is advisable to use short-acting pharmaceuticals in pre-hospital care.
- A CT scan is a basic diagnostic procedure. It should always be performed after basic circulatory and ventilation stabilization of the patient, then with a time interval of 12-24 hours, and always when there is a change in the clinical condition or pathology in the monitored values. It cannot always be performed in the case of a rapidly progressing epidural hematoma with clear clinical symptomatology. The indication for the examination depends on the local conditions, it must not be the cause of a time delay with regard to the surgical solution.
- A topogram of the C spine must be performed to rule out a C spine lesion. In the case of a mechanism of injury that is suspicious for an injury to the C spine, perform a CT examination of C1-C3 and then of the location where there is a suspicion of trauma during the performed topogram. Until the C spine lesion is excluded, the child must have a fixation collar.
- After exclusion of a C spine lesion, head drainage position is indicated.
- Basic therapy includes adequate analgesation.
- The absolute indication for measuring ICP is a GCS of 8 or less, or a positive CT scan with a focal neurological finding that threatens the development of brain edema.
- The absolute indication to measure SvjO₂ is an increase in ICP > 20 torr. For technical reasons, continuous measurement can be performed in children over 10 years of age. For smaller children, it is necessary to perform intermittent measurements. In this case, a bed-side (more precisely, near point patient) blood gas analyzer must be available.
- Mannitol is indicated for interstitial brain edema, when there is a risk of brain herniation. Serum osmolality > 320 mOsm/l is a contraindication. During the therapy of traumatic brain edema, it is advisable to maintain serum osmolality > 310 mOsm/l.
- Infusion therapy must be conducted in such a way as to stabilize the circulation, crystalloids 1/1 FR or 1/1 Ringer are used, from colloids preferably hydroxyethyl starch. Glucose is supplied in an amount ensuring normoglycemia. Insulin is not administered except for diabetics.
- The indication for thiopental coma is uncorrectable intracranial hypertension and an uncorrectable discrepancy between the supply and supply of oxygen to the brain. The thiopental level must be monitored and maintained in the range of 25-40 mmol/ml.
- Another therapeutic measure in the treatment of uncontrollable intracranial hypertension is hypothermia with a decrease in the core body temperature to 34°.
- Measurement of tissue values - Neurotrend - due to technical inaccessibility does not yet belong to routine monitoring.
- Decompressive craniectomy is indicated by a neurosurgeon in conservatively uncontrollable intracranial hypertension. Reactive coma with malignant brain edema immediately after injury is not an indication for decompressive craniectomy.

- When the condition worsens or the ICP increases, it is always necessary to consider the possibility of neurosurgical intervention.
- Investigation of BAER evoked potentials is appropriate. The result is not distorted by analgesation or barbiturates.
- Every child after a severe craniocerebral injury must be monitored for a long time by a pediatric neurologist and, depending on the condition, by other experts.

Links

Source

- HAVRÁNEK, Jiří: *Trauma CNS*.