Cerebral Haemorrhage: The Extracerebral Bleedings

Intracranial haemorrhage are differentiated between the extra- and intracerebral bleedings. The following article only deals with extracerebral bleedings, where a bleeding between the skullcap (calvaria) and the brain parenchyma occurs. You will gain a general overview over the different cerebral haemorrhages, their possible causes and their radiomorphologic classifications. Finally, this article provides a perspective regarding the possible consequences of a cerebral haemorrhage.

Formation of Cerebral Haemorrhage within the Three Spaces

In the brain, a distinction is made between 3 spaces in which bleeding can occur depending on the cerebral membrane (meningen): These potential spaces include the epidural, the subdural, and the subarachnoid space. The subarachnoid space differs from the other two spaces to the extent that it also exists physiologically in the brain. The epidural and subdural spaces, however, are artificially created by the accumulation of blood between the internal lamina of the calvaria and the dura mater (epidural haemorrhage) or between the dura mater and the arachnoid mater (subdural haemorrhage).
Cranio-crebral injuries are among the most common causes of death until early adulthood and require immediate treatment. There is no storage of oxygen in brain, so it is dependent on blood vessels for supply of oxygen and essential nutrients. A hemorrhage in brain can cut off this supply and cause death.

The clinical manifestation can provide first indications regarding the aetiology. For an exact diagnosis, however, a computer tomography (CT) is always indicated in emergency situations. Depending on the type of bleeding, there are different radiomorphologic criteria that are characteristic for the respective bleeding.

**Definition of Epidural Haemorrhage**

![Image: "Epidural hematoma at the fracture (arrow) of the skull" by Hellerhoff. License: CC BY-SA 3.0](image)

The epidural haemorrhage (epidural = above the dura mater) or extradural haemorrhage is a bleeding between the inside of the calvaria and the outer periosteal layer of the dura mater, whereby this space in the brain does not exist physiologically. The source is usually an arteri al bleeding, most commonly from the middle meningeal artery or any of its branches, as they are especially vulnerable to rupture in skull fractures, due to them being bound quite firmly to the cranial bone. An epidural haemorrhage is most commonly caused by a head injury commonly associated with fracture of skull.
(85-95% of cases), which, by definition, is linked to a malfunction or injury to the brain. A plain injury to the head is called a cranial contusion (bruise).

**Symptoms of epidural haemorrhage**

During the clinical presentation, in approx. 30% to 40% of the cases, two periods of unconsciousness occur. The *initial loss of consciousness* is caused by the trauma itself, whereas the *second phase of unconsciousness* is caused by the arterial bleeding displacing the brain parenchyma. It is many times accompanied with severe headache.

The phase in between is referred to as the “free interval” and is typical for an epidural haemorrhage. An increased intracranial pressure during the course occurs due to the intracranial compression.

Symptoms that can be attributed to an increased intracranial pressure include drowsiness, nausea and vomiting, seizure and an increasing loss of consciousness. In addition, there may be a so-called “papilledema” – optic disc swelling. Furthermore, an epidural haemorrhage leads to a rapid compression of the 2 cerebral hemispheres and, as a result, contralateral symptoms such as e.g. a motor coordination disorder with symptoms of paralysis (inability to move). The hemorrhage can lead to neurological damage. due to this, the patient is conscious in one moment and becomes comatose in another and often die in minutes.

**Diagnosis of epidural haemorrhage**

An epidural haemorrhage is a serious condition and emergency treatment is needed. After having the patient stabilised, a computed tomography (CT) of the head is indicated to be able to detect or rule out any bleeding. Acute epidural haemorrhage appears in the CT hyperdense with a typical bi-convex patch with a swirl sign. Besides the CT, the MRI (Magnetic Resonance Imaging) is also used. Both
methods are equally suited to confirm the diagnosis. X-ray is done to find out fractures and its impact on the dura matter. Angiography is also preferred to rule out laceration of middle meningeal artery or extravasation of the artery into middle meningeal vein commonly called “tram track sign”.

**Treatment of epidural haemorrhage**

When treating an epidural haemorrhage, the **stabilisation** of the patient is the first priority. This includes under certain circumstances that the patient may need to be intubated, depending on the level of consciousness. Advance life support (ALS) protocol is followed focusing on cervical spine control and Airway Breathing circulation (ABC). Another important treatment approach is the prompt reduction of increasing brain pressure. To accomplish this, a **neurosurgical removal of the large haematomas** (collection of blood) or solid blood clots is indicated. It is done by craniotomy, clipping of source of bleeding blood vessel (diathermy) or decompressive removal of the haematoma. In this case, a hole is made in the calvaria (craniotomy), providing relief to the brain.

Intensive care measures to prevent or treat post-traumatic cerebral edema include, among others, elevation of the upper body of the patient up to 30°, ventilation of the patient, the administration of plasma expanders, osmotic therapy (= administration of hyperosmolar solutions such as mannitol) as well as the administration of barbiturates or saluretics. The administration of cortisone, which also lowers the intracranial pressure by reducing the swelling of the oedema, is not indicated in a traumatic brain injury, as this, according to studies, has resulted in an increased complication rate.

**Note:** There is NO physiologically occurring epidural space in the brain.

**Definition of Subdural Haemorrhage**

The subdural haemorrhage (subdural = below the dura mater) is a bleeding in the potential space, a space artificially created by the haemorrhage (see epidural haemorrhage) between the dura mater and the arachnoid mater. The subdural haemorrhage is, in contrast to the epidural haemorrhage, a **venous bleeding from the bridging veins found in between venous sinuses and cortex**, whereas the bleeding as such is usually also caused by trauma. Due to the lower pressure, veins bleed more slowly and the space fills much more slowly than with arterial epidural haemorrhage. Intracranial hypotension and dural metastases are other causes of subdural haemorrhage.
Symptoms of Subdural Haemorrhage

The subdural haemorrhage clinically resembles the epidural haemorrhage as it also results in symptoms such as increased intracranial pressure, nausea or vomiting. However, due to the slower onset, these symptoms can also occur during progression and are usually less pronounced than in an epidural haemorrhage.

The most prominent clinical symptom is a rather slow progressing so-called organic brain syndrome as well as a hemiplegic symptom with focal failures that can lead to focal seizures. A change in personality and the impairment of intellectual functions are a part of an organic brain syndrome, causing the patients to frequently seek psychiatric aid.

Fluctuating conscious level, sleepiness, headache and confusion are the symptoms of subdural haemorrhage. Due to the slow development of the subdural haematoma, it can become chronic and, only in the progress, independent of the previous trauma, acutely symptomatic. The neurological deficits arising from this are limited to one part of the body (hemiplegic symptoms) and are, therefore, often mistaken for an acute “stroke”.

Diagnosis of subdural haemorrhage

The emergency diagnosis used for the subdural haemorrhage is the same as for the epidural haemorrhage, the computer tomography (CT) scan. Other diagnostic possibilities include the MRI or the angiography. In general, in the CT, the acute subdural haemorrhage appears hyperdense and crescent-shaped. When bleeding is older than one month, the detection of a subdural haemorrhage is much more likely with a MRI because the bleeding in the CT often already appears isodense bilaterally at this stage.

Treatment of subdural haemorrhage

The treatment of subdural haemorrhage is also based on the neurosurgical removal of the haematoma by burr twist drill and burr hole craniostomy or craniotomy. The
faster the haematoma is removed, the better is the prognosis.

**Note:** There is NO subdural space in the brain.

**Definition of Subarachnoid Haemorrhage**

The most common cause of a subarachnoid haemorrhage is the rupture of an **arterial aneurysm** (blood vessel bulge) of the **basilar arteries**. 40 – 50 % of aneurysms, and therefore the majority, can be found on the **anterior communicating artery**, followed by the posterior communicating artery and the ophthalmic aneurysm (20 – 30 %). In addition to the innate (congenital) aneurysms, there are also acquired aneurysms, for example, in connection with a bacterial infection or trauma.

**Other possible causes of a subarachnoid haemorrhage are:**

- Angiomas
- Arteriovenous malformations
- Primary intracerebral haemorrhage
- Tumours
- **Blood disorders** such as haemophilia
- Anticoagulant therapy
- Avitaminosis
- Cerebral venous sinus thrombosis

The bleeding occurs in the subarachnoid space which also exists physiologically (= below the arachnoid). The **bleeding itself can either occur spontaneously, through trauma or** be triggered by certain factors. Possible **trigger factors** in this context are mainly activities that cause an increase in intra-abdominal pressure such as coughing, bending or lifting heavy loads.

All in all, however, **bleeding occurs during resting phases**. Besides these triggering factors, there are also a number of risk factors which are associated with a subarachnoid haemorrhage. The main risk factors are **hypertension, nicotine, bleeding disorders, mycotic aneurysm or fall in estrogen after menopause and alcohol abuse**. Possible
complications in the course of a subarachnoid haemorrhage are a vasospasm of the vessels (especially during the period of the 3rd to 10th day after the bleeding), recurrent bleeding and hydrocephalus aresorptivus.

Symptoms of subarachnoid haemorrhage

The most characteristic symptom of the subarachnoid haemorrhage is the sudden onset of the so-called “thunderclap headache”, which is located in the neck and in the forehead region. Neck stiffness (meningism) may be present due to meningeal irritation. Other possible symptoms include nausea, vomiting, photophobia, collapse, seizures or a decreased level of consciousness, and coma which are the result of the increasing intracranial pressure. Headaches can also occur as a warning symptom of an impending aneurysm bleeding.

Diagnosis of subarachnoid haemorrhage

Due to the fact that the bleeding occurs in the subarachnoid space which contains the cerebrospinal fluid, in case of a subarachnoid haemorrhage, blood is present in the cerebrospinal fluid. Depending on the age of the bleeding, this fluid has a salmon or xanthochromic discolouration. The cerebrospinal fluid can be obtained by a procedure called lumbar puncture. However, it is important that previous contraindications must be excluded. Xanthochromic blood is detected in CSF due to presence of bilirubin from the break down of hemoglobulin. Contraindications can be an increased intracranial pressure or a low platelet count. Besides the lumbar puncture, the CT and the angiograph play an important role in diagnosing a subarachnoid haemorrhage. It detects intraparenchymal or intraventricular hemorrhages as hyperdense areas. The angiograph is particularly necessary for the precise localisation of the aneurysm.

Treatment of subarachnoid haemorrhage

There are two treatment methods available if an aneurysm has been identified; the “clipping” in which the aneurysm is neurosurgically eliminated from the outside and the “coiling”, whereby metal spirals (coils) are inserted inside the aneurysm through the blood vessels via a catheter, sealing the aneurysm. Intracranial stents and balloon remodeling can be used to treat wide necked aneurysms.

Summary of the Differences

<table>
<thead>
<tr>
<th></th>
<th>Location of bleeding - between:</th>
<th>Type of bleeding</th>
<th>Primary Cause</th>
<th>Morphology in the CT scan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidural haemorrhage</td>
<td>Skullcap and Dura mater</td>
<td>Arterial</td>
<td>Traumatic</td>
<td>Lentiform, bi-convex</td>
</tr>
<tr>
<td>Subdural haemorrhage</td>
<td>Dura mater and Arachnoid</td>
<td>Venous</td>
<td>Traumatic</td>
<td>Crescent shaped</td>
</tr>
<tr>
<td>Subarachnoid haemorrhage</td>
<td>Arachnoid and Pia mater</td>
<td>Arterial</td>
<td>Aneurysm</td>
<td>Detection of blood in the cisterns, between the sulci</td>
</tr>
</tbody>
</table>
Possible Consequences of a Cerebral Haemorrhage

When referring to the consequences of a cerebral haemorrhage, especially the type and size of the bleeding and the possible comorbidities play a role. Another important factor that plays an crucial role with respect to the type of permanent damage is the precise localisation of the bleeding. An example hereto may be the cause of permanent speech disorders (aphasia), motor skill disfunctions or sensory disturbances due to CNS deficit. Hydrocephalus and raised intracranial pressure are some of the complications. To minimize the lasting damages, an early rehabilitation is crucial. This already begins during the hospital stay and is then continued in specialized institutions.

Coma as a consequence to a brain haemorrhage

A possible consequence of a cerebral haemorrhage is the coma, which is one of the quantitative disturbances of consciousness and defined by the fact that the patient cannot be awakened by any kind of external stimulation. Consequently, also brain death, the irreversible failure of the brain, can be, by definition, assigned to the coma.

The cerebral haemorrhage is alongside the cerebral ischaemia, one of the main causes of a coma. Other causes that can result in a coma include encephalitis or severe brain trauma. Initially, a comatose condition, for example in connection with intoxication or in relation to metabolic disorders (diabetes mellitus, uremic and hepatic coma) is excluded, since they must be treated immediately. Therefore, part of the diagnosis of a comatose patient is a laboratory examination, including the determination of the blood count, blood sugar levels, the liver and kidney parameters, electrolytes, thyroid levels and other parameters subject to clinical suspicion.

A third-party anamnesis to give a tentative diagnosis is especially important because it can give the first clues to the aetiology of the coma. In addition, a neurological examination of the patient is carried out, which, according to the summary of findings, may provide an indication of the severity and location of the injury. Based on the Glasgow Coma Scale, the severity of the disturbance of consciousness can be quantified. Within this scale, a value of 15 points can be achieved at best, while three points are the minimum. In the course, further examination equipment such as the CT or MRI are indicated.

There is also significant chances of re-bleeding in cerebral spaces in first two months which can be life threatening.

Review Questions

The correct answers can be found below the references.

1. Which statement about the epidural haemorrhage is correct?
   A. There usually is a venous blood flow.
   B. The CT characteristically shows a bi-convex hyperdense area.
   C. An epidural haemorrhage often occurs spontaneously.
   D. During its course, it usually presents a chronic progression.
   E. The bleeding occurs between the arachnoid and dura mater.

2. Which statement about the subdural haemorrhage is not correct?
A. The bleeding occurs between the dura mater and arachnoid.
B. Causes are usually venous bleeding from the bridging veins.
C. In the CT, the subdural haemorrhage presents a crescent shape.
D. There is also a chronic progression form of the subdural haemorrhage.
E. The subdural haemorrhage is usually caused atraumatic.

3. Which statement to the subarachnoid haemorrhage is not correct?

A. The bleeding occurs between the arachnoid and pia mater.
B. It is an arterial haemorrhage.
C. The main cause is a haemorrhage from an aneurysm of the basilar arteries.
D. The basilar arteries are most commonly affected by aneurysms.
E. As part of a subarachnoid haemorrhage, a stiff neck (meningism) can occur.

References

Correct answers: 1B, 2E, 3D

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