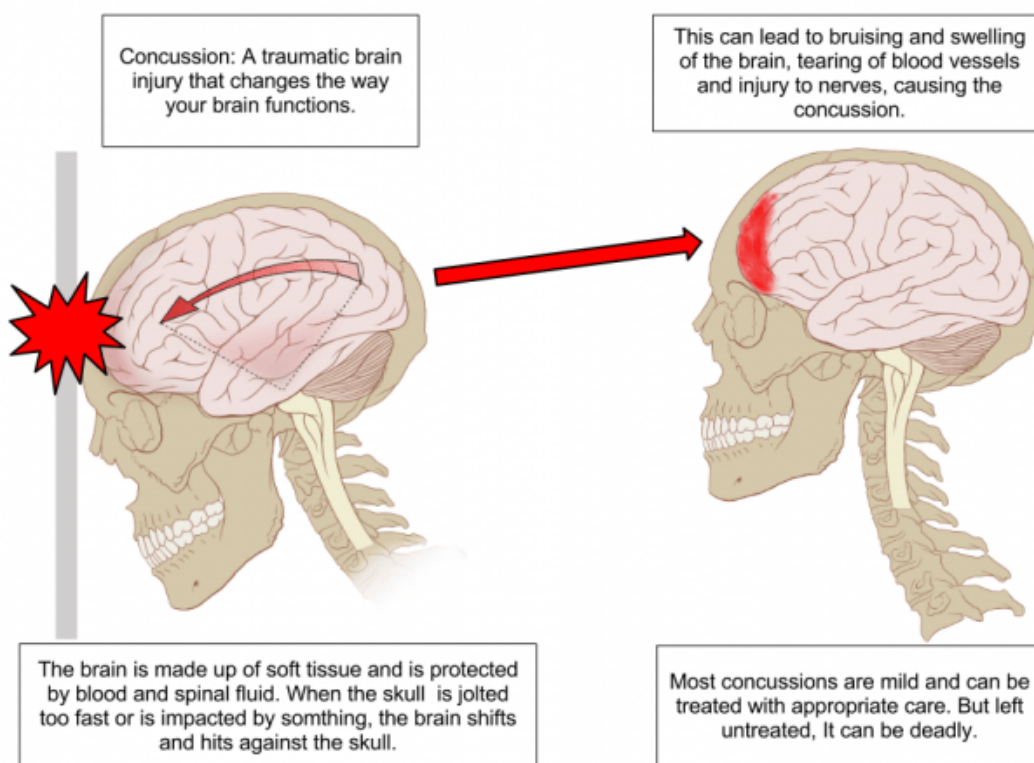


Forensic Traumatology – Blunt and Penetrating Trauma

[See online here](#)

Due to its clinical relevance, questions on forensic traumatology are often asked in tests and exams. Proper names, in particular, are regularly tested in the context of case descriptions. This article provides an extensive overview of the different injury patterns of blunt and penetrating trauma, which will help you to answer all the questions on the topic.



Blunt Trauma

Definition: blunt trauma

Blunt trauma is defined as the single or repeated impact of an object without sharp edges or sharpened surfaces on the body. We distinguish between direct trauma when the injury occurs in the same location of the trauma, and indirect trauma, when there are 2 different locations. Deceleration traumas are part of the latter. An example is the laceration of the aorta by negative acceleration (sudden braking).

In the case of profiled tools, the injury picture often gives some indication of the weapon used for the crime and the mechanism of impact (e.g., the butcher's hammer). The

same applies to bite wounds, at which the dental crown imprints and the malposition of teeth allow the identification of the perpetrator.

Injuries of Skin and Soft Tissue

Abrasion

In the case of superficial abrasion, only epithelial desquamation without or only punctate bleeding can be found. The horny layer is pushed together in the direction of the abrasion. The so-called **epithelial moraine (ship's bow phenomenon)** is found at the end of the abrasion.

Postmortem abrasion can be recognized by yellow-brown dried out spots, whereas serous exudation causes sloughing of the living tissue. Excoriations reach into the stratum corium and, in some cases, they bleed severely. In cases of the **avulsion**, the whole corium detaches like during a scalping procedure.

Decollement

This is the shearing of the cutis and the subcutis without opening the skin. This leads to the development of a bag which is massively filled with blood. This kind of injury is typical for accidents in which pedestrians are run over.

Intracutaneous bleeding

This kind of dermatorrhagia is called **suggillation**. They cannot be pressed away and can provide answers regarding the weapon used in the crime. One distinguishes between the positive imprint, e.g., in the shape of the sole of a shoe, and the negative imprint, which can be found at stick blows. The result is a typical **double outline**.

Hematoma

Hematoma is a pooling of blood under the skin, in which positive and negative imprints can be found. The coloration allows an estimation of the age of the injury. When the color is grey-blue the injury is fresh, blue-violet is a few days old, a greenish coloration appears after 4-5 days at the earliest, and a yellowish coloration after approx. 8 days.

Contusions and lacerations

These skin wounds are frequently found on the head since the skull bones serve as an abutment. They result from compressive, tensile, and shearing forces. Their characteristics are irregularly shaped, serrated wound margins, abrasion seams around the wound, and tissue bridges (blood vessels and nerves) in the deep. Collections of blood are often found in the surroundings. In this sense, it is very important to search for foreign bodies like glass or varnish fragments. In terms of differential diagnoses, incised wounds should be considered.

	Contusions and lacerations	Incised wound
Wound margin	Irregular, abrasions, squashed	Smooth, cuneiform, gaping
Wound bed	Tissue bridges, bloodshot, foreign bodies	Profuse bleeding



Image: "Stitched wound" by Carten Niehaus, License: [CC BY-SA 1.0](#)

It is important to mention that the dimension of the injury pattern also always depends on the clothes, the age of the victim (older people often have vulnerable, thin skin), and the bleeding tendency (coagulopathies and anticoagulant intake).

Concerning head injuries, the '**rule of the hat brim**' states that blow and impact injuries mostly occur above a fictional line, like the 1 of the brim of a hat. Falling injuries, however, are most frequently found below this line. This rule does not apply to injuries caused by falling down the stairs. Along with location above hat brim line, left side lateralization, and a large number of lacerations also favor a blow.

Injuries of Inner Organs

The injuries are classified in ascending order by the underlying force intensity:

- **Commotion:** concussion or slight bruise without consequential damages
- **Contusion:** severe bruise with possible consequential damages
- **Compression:** internal bruising which is often accompanied by tissue lesions or bleedings. Frequently, permanent damage is expected.
- **Rupture:** separation of the tissue with bleeding and, thus, ischemia (e.g., [spleen rupture](#) - or bursting of filled hollow organs like the heart and the gall bladder). There are always permanent damages or at least scarring.

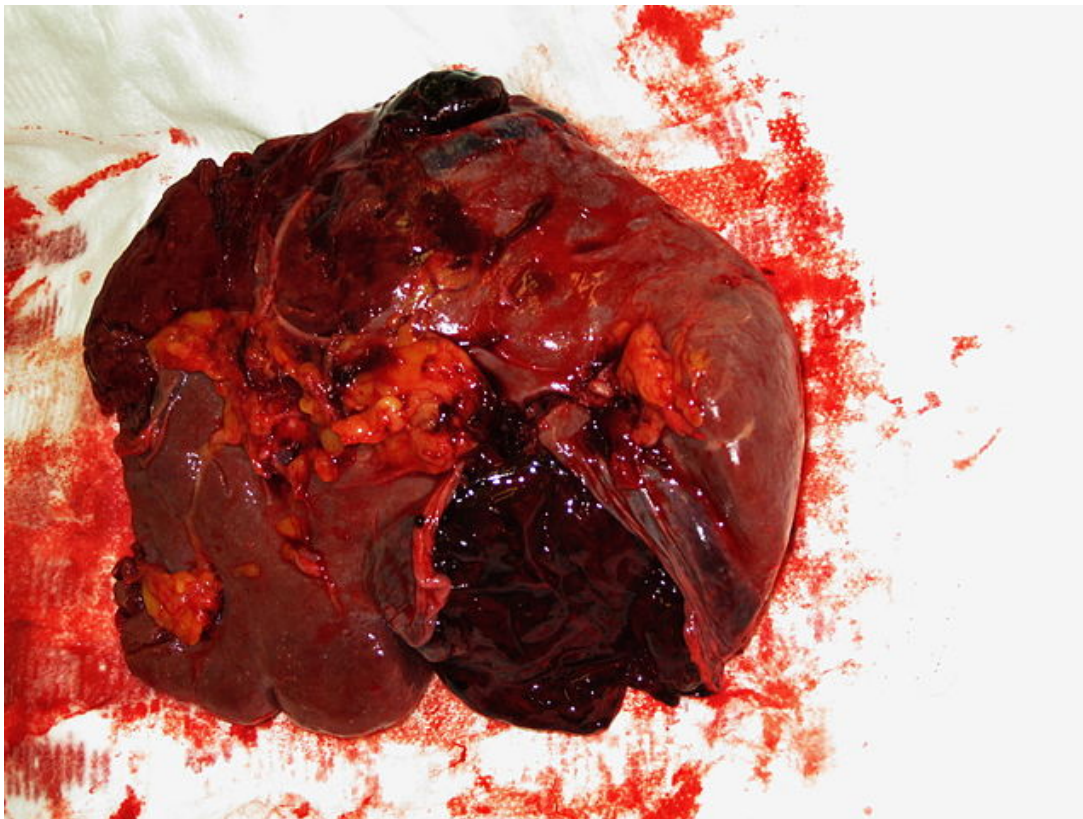


Image: "Bilateral traumatic splenic rupture grade 3-4" by Thomas Zimmermann, License: [CC BY-SA 3.0 DE](https://creativecommons.org/licenses/by-sa/3.0/de/)

Bone Injuries

The localization and shape of bone fractures often allow conclusions about the type and intensity of the trauma. Bone splinters can lead to open penetrating fractures.

In the case of long bones, we distinguish between the direct and indirect bending fracture. In the indirect bending fracture, the force is applied at the ends of the bone so that the bone shaft breaks. In some cases, wedge-shaped fragments result. Here, the base of the wedge is on the opposite side of the force application.

The spiral fracture is caused by indirect rotational overloading of the longitudinal axis. When direct bending fractures occur, the so-called **cutler wedge** often develops. Its base is located on the side of the force application. This is a typical fracture in cases when pedestrians are run over by cars.

Skull fractures can also be divided into bending and bursting fractures. Bending fractures result from direct localized trauma. They include:

- **A hole or stamping fracture:** This is a depressed fracture due to the vertical impact of an object of maximum 4 x 4 cm, e.g., the blow of a hammer.
- **Lamellar tearing:** It results from the oblique impact of a tool via tilting.

Bursting fractures, however, result from indirect, transferred trauma. The results are deformations of the skull and extensive compressions with fractures due to tensile force. These fractures are mainly found at the base of the skull. Transversal pressure leads to transverse fractures and longitudinal pressure to oblique fractures.

So-called **hinge fractures** (transverse fracture of the base of the skull) can be found when kicks are carried out against a head that is fixed to the floor, the so-called curb-

stomping.

A **globular fracture** is a special form of the bending and bursting fractures. It results from large tools or impaction areas with circularly and radially arranged fracture lines in the shape of a spider's web, e.g., due to beating with a stone.

The impaction of the spine into the inside of the skull results in **basilar skull ring fractures**. They are the typical evidence of a jump from a great height, because, as opposed to someone falling or being thrown, this injury mechanism requires the person to land on his feet.

Puppe's rule is essential for the assessment of the temporal sequence of skull injuries. It states that fracture lines of a second injury end at the fracture lines of the 1st trauma at a 90° angle. E.g., this is important in case of a punch on the head and the following impaction on the floor.

Clinical signs of skull fractures are monocle or glasses hematomas, bleedings, or cerebrospinal fluid outflow out of the auditory canal.

Injuries of the Meninges

Epidural hematoma

Epidural hematomas originate between the skull bone and the dura mater. The underlying cause is an injury of the meningeal artery which is often seen in the course of skull fractures. This results in bleedings with protrusion of the dura mater with increasing compression of the brain. Typically, an interval free of symptoms (minutes to hours) occurs before the onset of the symptoms due to the increased intracranial pressure. There is a risk of misinterpreting this as an alcoholic stupor. The convex space-consuming lesion is typical in the computed tomography (CT) scan. The free blood volume of more than 100 mL is lethal.

Subdural hematoma

When there are lesions of the bridging veins, bleedings between the dura mater and the arachnoid mater occur. Normally, this occurs traumatically in cases of acceleration-deceleration traumas, e.g., shaken baby syndromes in child abuse. There is a long interval free of symptoms, and the formation of a chronic subdural hematoma due to bloody oozing is possible. The typical concave shape can be seen in the (CT) scan.

Subarachnoid bleedings

In this case, bleedings occur under the arachnoid mater as contusion bleedings due to skull traumas or rupture of an aneurysm. The bursting into the subdural space is possible.

Brain Injuries

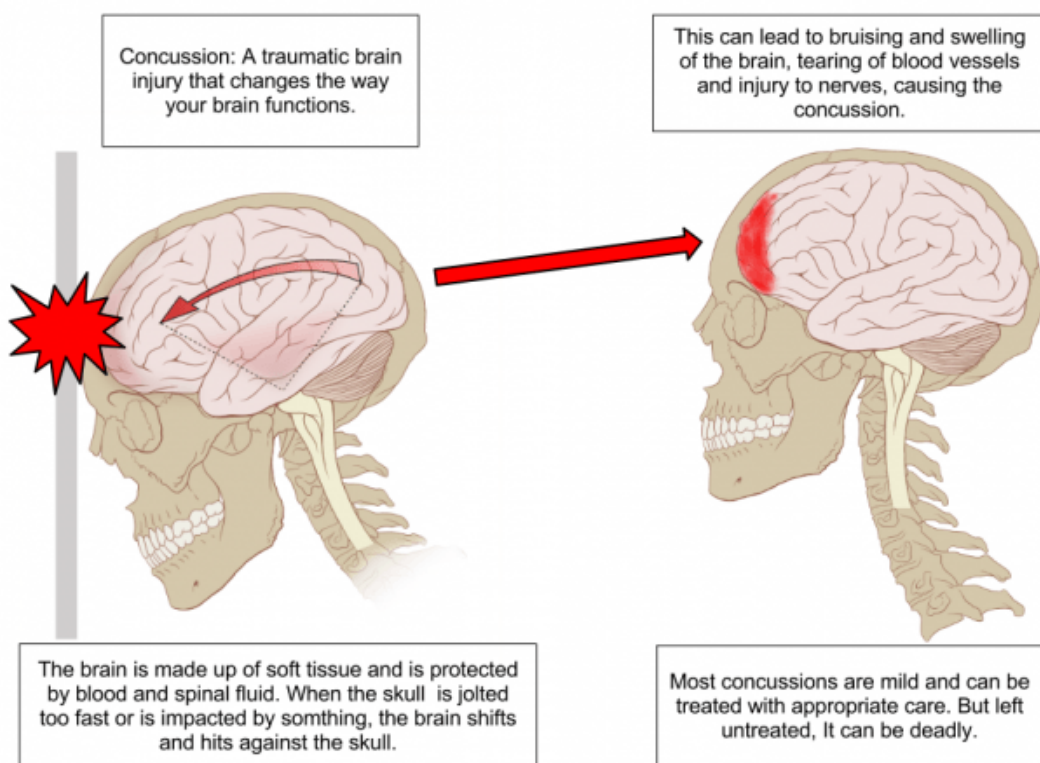


Image: "Concussion Anatomy" by Max Andrews, License: [CC BY-SA 3.0](https://creativecommons.org/licenses/by-sa/3.0/)

Comotio cerebri (concussion, SHT I°) is a transient, completely reversible impairment of brain function. Clinical symptoms are unconsciousness, headache, vertigo, nausea, and retrograde amnesia. There is no traceable defect of brain substance.

Contusio cerebri (brain contusion, TBI II°): The bruising of the cortex on the side of impaction is referred to as coup; bruising on the opposite side is called contrecoup. The contrecoup is mostly more distinct than the coup due to suction effects or superposition of pressure waves. Morphologically, there is bruising, bleedings, and edemas. After re-absorption, a plaque jaune develops as a late sequela.

Compressio cerebri (central brain injury, TBI III°) results primarily from trauma or as a terminal consequence of intracranial pressure. Fluid retention makes the brain swell. There is the risk of constriction in the foramen magnum (malignant brain edema) with central death.

Reflex Death

Definition: reflex death

Blunt-mechanic trauma that does not cause death directly but immediately. The injured organ, referred to as reflectogenic zone, is not identical to the target organ, but the stimulus is transferred to the target organ via the brain stem, mostly through the heart-circulation-system.

Carotid sinus reflex: The carotid sinus is a small expulsion of the internal carotid artery, just after the bifurcation of the common carotid artery. Here we find baroreceptors regulating blood pressure by decreasing the heart rate. The exogenous pressure on the carotid sinus - like a karate chop against 1 or both sides of the neck, or impaction on the

neck after falling or at a traffic accident – results in continuous bradycardia with circulatory collapse. Typical findings are traumatic changes at the carotid sinus like bleedings or rupture of the inner layer and slightly extended signs of vital reaction.

Solar plexus reflex: The solar plexus is a part of the vegetative nervous system. It lies in front of the aorta around the branching of the superior mesenteric artery. Here, the stimulation of the plexus also leads to a reflective decrease in heart and circulatory activity with possible death. E.g., this occurs when someone is punched in the stomach or through the impaction of the belly onto a hard water surface.

Penetrating Trauma

Definition: penetrating trauma

Penetrating trauma is defined as the mechanic impact of sharp, semi-sharp, or pointy objects like knives, hatchets, scissors, or glass fragments. The lethal cause is mostly a lesion of vessels, especially in the area of the neck and the clavicle.

Different lesions

Stab wounds are the consequence of tissue disruption with pointy instruments which are mainly held perpendicular to the body surface and create a deep canal so that the wound is more deep than wide. Due to the elasticity of the skin, the wound can be greater in-depth and width than the instrument. Sometimes, imprints of the grip can be found when pressing the soft tissue.

The margins are smooth and the wound angles are pointy. If the victim turns while the instrument is pulled out or if the perpetrator turns it, the wound is ultimately shaped like the tail of a dove and allows us to make conclusions concerning the reconstruction of the crime.



Picture: "Sharps injury" by Rosmarie Voegtli. License: [CC BY 2.0](https://creativecommons.org/licenses/by/2.0/)

Cuts create longitudinally running sharp tissue disruption if the instrument was mainly inserted in parallel or tangentially to the body surface. The wound margins are smooth and the wound angles are pointy. However, the wound is overall wider than deep. Gaping wounds form in cuts along fissility lines of the skin.

The injury by stroke originates as a consequence of a beating injury with a heavy weapon that has at least 1 cutting side, like axes and machetes. It is a combination of a cut and a

contusion with hematomas, abrasions, and, in some cases, tissue bridges. Deeper running structures like bones can also be injured.

Impalement injuries are perforating injuries caused by a blunt, elongated object. There are contusions and abrasions at the wound margins.

Dismembering is a special form in which the body is fragmented in a high-speed trauma. Examples are traffic accidents, being run over by a train, or accidents with a ship's propeller.

Regarding the assessment of stab and cut wounds, the possibility of self-infliction for a pretense of a crime or suicide has to be considered.

Self-infliction / suicide	Homicide
Single stabs or close together	Multiple stabs
Heart region	Different stab, cut regions
Small depth of stabs/cuts	Deeper, broken stab canal, unreachable for the person himself, on the back
Bare skin	Cut clothes
Testing wounds, parallel testing cuts	Defensive wounds, different cut directions
Vertical traces of blood flow	Turbulent blood traces, backward

Features of neck cut injuries

	Suicide	Homicide
Localization	Lateral	Mid-line
Cut direction	Descending to the leading hand	Horizontal, circular
Hesitation wounds	Present	None
Collateral injuries	Well reachable, vulnerable locations, hollow, grouped, parallel, constant intensity	Everywhere, also on the back, random arrangement, changing intensity
Testing cuts	Contralateral side of the neck, the crook of the arm, wrist	None
Defensive wounds	None	Hands, forearm
Traces of blood flow	Consistent, vertical	Irregular
Clothes	Intact	Possibly damaged

Likewise, cuts can be also found on a corpse to cover up a homicide or pretense of suicide. Absent bleeding suggests postmortem infliction.

In cases of penetrating trauma, there often are defensive wounds in the area of the upper extremities. Cutting wounds in the **shape of a fish mouth** can be found on the fingers if the person has grabbed the blade.

Forensic Aspects

From a legal point of view, penetrating violence is often associated with a greater threat of punishment than blunt violence.

Often, the assessment of the victim's capacity to act is necessary for the reconstruction of the crime. Capacity to act means both the ability to perform complex, targeted actions, as well as instinctive defense and reflexes.

Incapacity to act due to immediate death takes place in case of decerebration, rupture of the aorta, the pulmonary artery or both carotid arteries, and a greater (> 3.5 cm) opening of the heart. In cases of smaller stab wounds of the heart or rupture of peripheral arteries, it is often possible to still be capable to act for a period of several minutes up to

hours. Most of the time, perforating abdominal injuries allow long capacity to act since the peritoneal shock occurs only in some cases and the victim slowly bleeds to death.

Note: Capability to act is not equal to survival time.

The spectrum of the causes of death in case of penetrating trauma encompasses internal or external bleeding, air embolism, aspiration of blood or foreign objects, pericardial tamponade, pneumothorax, and late sequelae like infections.

Important for the diagnosis of death-inducing bleedings are reduced postmortem lividities, paleness of the inner organs, subendocardial bleeding, emptied spleen, or shock signs of the kidney (pale cortex, hyperemic medullar cone).

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