1. Gunshot Wounds

Depending on the type of weapon a distinction is made between *handguns* (pistols, revolvers), *rifles* (e.g. carbines and military assault rifles, hunting rifles), *shotguns* and *many special forms* such as blank cartridge guns, slaughterer's guns, air rifles etc.

Modern pistols have a magazine that is inserted into the grip; after firing a cartridge its case is ejected, as the slide is recoiling. Revolvers have a rotating cylinder holding the cartridges; after firing a shot the case remains in the chamber.

A **rifled barrel** has a spiral pattern of grooves and elevations (lands) on its interior surface. These cause the bullet to rotate about its longitudinal axis ("twist"); this gyroscopic spin stabilizes the bullet on its trajectory.

![Diagram of gun barrel parts](image)

1. Calibre (inner diameter of a barrel)
2. Groove
3. Land
4. Imprints of lands on the jacket of projectile

The **smooth bores** of shotguns do not have spiral grooves and lands. They are designed for firing shot shells. The front part of the cylindrical barrel may be slightly tapered (choke bore to reduce dispersion of the pellets).

The **calibre** of a projectile represents its diameter in millimeters or inches (e.g., or 6.35 mm corresponding to .25 in.; 7.65 mm corresponding to .32 in.). The calibre of shotgun barrels is not identical to its inside diameter, but a measurement based on history (shot calibre 12 has an inside diameter of 18.2 mm, whereas calibre 16 has an inside diameter of only 16.8 mm).
1.1 Ammunition

The **cartridges** of handguns and rifles consist of a *case* and a *bullet* (projectile). At the bottom of the case there is the *primer* and above it the *propellant* (nowadays usually smokeless nitro powder).


The **cartridges** of handguns and rifles consist of a case and a bullet (projectile). At the bottom of the case there is the primer and above it the propellant (nowadays usually smokeless nitro powder). For ancient weapons or replicas, black powder (consisting of potassium nitrate, charcoal and sulphur), which has been known for centuries, is also used. The explosive burning of the propellant produces an ample amount of gases that are under high pressure and give the respective acceleration to the projectile. Muzzle velocity of bullets fired from handguns is around 300 m/s; for hunting and military rifles, it is considerably higher (approximately 700 - 1000 m/s). Cartridges with *full-jacketed bullets* are typically intended for pistols and military rifles. *Semi-jacketed bullets* are used for hunting (the projectile that is not jacketed at the tip possesses a higher deformability thus transferring more energy to the animal body). Ammunition for revolvers and small calibre weapons (5.6 mm corresponding to .22 in.) often has non-jacketed full-lead bullets.
**Shotgun shells** are fired from smooth bore shotgun barrels. Instead of a single projectile they usually contain a large number (200 - 500) of spherical pellets made of hard lead. The diameter of the pellets ranges from 2 to 4.5 mm; velocity on leaving the barrel is about 300 m/s. The cartridge cases consist of cardboard or plastic; the bottom (usually made of brass) contains the primer. The space above the brass head contains a charge of propellant, nowadays mostly smokeless nitro powder. Pellets and powder are separated by intermediate layers (felt wad or plastic wad with pellet cup). Apart from conventional shotgun ammunition, there are also cartridges with extraordinarily small or big pellets, with rubber projectiles, and with single lead projectiles (shotgun slugs as the Brenneke, the Sabot slug or the Foster type).

1. Over-shot disc
2. Case
3. Bottom of case
4. Primer
5. Gunpowder
6. Inner case
7. Under-wad disc
8. Wad
9. Plastic container
10. Pellets
11. Stellate closure of case
1.2 Wounding effect

The **injuring effect** of a projectile is based on direct tissue destruction along the wound track on the one hand and lesions apart from it on the other, the latter caused by changes in pressure and by displacement of tissues (due to stretching and shearing forces). High velocity projectiles produce a *temporary wound cavity* that pulsates a few times and can be considerably larger than the permanent wound track. In fluid-filled organs (heart, urinary bladder) or in the neurocranium the radial expansion may lead to a "hydrodynamic explosive effect" with bursting of the encasing structures. If in such cases the brain is flung out of the cranial cavity in toto, this is referred to as "exenteration shot"; *Krönlein shot*. Even in cases with less transfer of kinetic energy, the shot may cause fractures of the skull and cerebral contusions away from the wound track.

![Diagram of Wound Cavities](image)

A. Temporary wound cavity  
B. Permanent wound cavity
1.2 Entrance wound, exit wound

The **entrance wound** is typically characterized by the following features: *a central aperture* (circular or oval) due to loss of tissue, *the rim of the hole denuded of epidermis* ("abrasion collar"), *a grayish-black "ring of dirt"* ("bullet wipe-off", "grease ring") provided that the projectile did not pass through another primary target before, and - in cases of close-range shots - *deposits of soot and/or gunpowder particles*. The size of the permanent entrance hole is not only dependent on the diameter of the projectile, but also on the elasticity of the tissue; therefore the skin wound does not allow the drawing of accurate conclusions as to the calibre of the bullet.

The **exit wound** is usually characterized by *a slit-like or stellate severance of tissue* with "clean" edges; the size of the skin wound often - although not always - exceeds that of the entrance wound.

According to the criteria of wound morphology, there are four **ranges of fire**: the *contact shot* (where the muzzle is in contact with the body), the *close-range shot*, the *medium-range shot* and the *distant shot*.
1.3 Range of fire

When a gun is fired with the muzzle held against the surface of the body (contact shot), soot-containing powder gases enter the wound and expand under the skin separating the tissue layers and causing a "pocket" with soot deposition. The entrance site is bloated by the expansion of the penetrating powder gases forcing the skin against the end of the barrel so that a patterned "muzzle imprint" is formed (corresponding to the constructional elements being in line with the muzzle as the foresight, the housing frame and the recoil spring guide of a pistol). If the entrance wound is above a bony support (e.g. in the frontal and temporal region) the balloon-shaped protrusion of the skin may rupture due to overstretching (stellate tears radiating from the bullet entrance hole).

In close- (short-) range shots gunpowder residues (soot and powder particles) can be identified around the entrance hole. The greyish-black soot leads to extensive skin discolorations of a cloudy nature; the intensity of smoke soiling decreases with growing firing distance. The maximum distance up to which a zone of powder soot blackening can be found varies depending on the weapon and ammunition.

If black powder ammunition is used, close-range shots may cause impressive changes in the skin due to heat (scorching). Shots with smokeless powder ammunition rarely cause macroscopically visible burns (sometimes if textiles made of thermo labile synthetic fibers are between the muzzle and the wound and the shot is fired from a distance of only a few centimeters).

The term medium- (intermediate-) range shot is used, if the bullet entry hole is surrounded only by unburnt or partly burnt powder grains deposited on, or forced into, the skin or the clothing ("powder tattooing"); in contrast to close-range shots, there is no smoke soiling discernible around the entrance wound.

In distant shots gun smoke and powder particles will not reach the target.
1.4 Shotgun injury

The pattern of **shotgun injuries** varies depending on the distance between the muzzle and the target: **Contact shots** are characterized by a large roundish defect with marginal abrasion, blackened wound edges and abundant soot in the depth of the wound. In **close-range shotgun wounds** the entrance hole is surrounded by soot and/or gunpowder particles. As the firing distance increases, the initially uniform hole shows scalloping of the margins; from a distance of about 2 m peripheral pellets produce satellite-like holes outside the central entrance defect. Firing ranges of several metres are characterized by a sieve-like wound pattern. If shots are fired from short distances, wads and/or plastic cups may penetrate the body together with the shot or cause excoriations of characteristic shape on the skin.

1.5 Captive bolt injury

**Livestock narcotic devices** are guns firing a cylindrical steel bolt about 10 cm deep into the brain of animals intended for slaughter, which usually results in immediate unconsciousness. In forensic practice, injuries from captive bolt stunners are seen primarily in suicide cases; homicides and accidents with fatal outcome are rare. The steel bolt has a conically grooved front with a sharp edge. After firing a blank cartridge has driven out the bolt, it returns into the device by means of air or rubber bushes or a withdrawal spring. Therefore, no projectile is left in the depth of the wound track, but material (skin and bone imprimatur). In some special types of slaughterer's guns the entrance wound pattern shows 2 (less frequently 4) roundish zones of powder soot blackening located in pairs opposite each other, which are due to identically arranged smoke conduits.
1.6 Suicide, homicide or accident?

To classify a gunshot wound as suicidal, homicidal or accidental a synoptic evaluation of the evidence obtained from the injuries and clothes, the results of the forensic investigations and the other circumstances of the case have to be made. From the medicolegal point of view, the question has to be answered whether the entrance wound is localized in a region typical of suicides (temple, mouth, cardiac region, forehead, submental region). In almost all cases of suicide, the muzzle is pressed against the body or inserted into the oral cavity; in shots into the chest, the skin is seldom bared beforehand. Handguns are found in the hand of the firing person in about one fifth of suicides of this type. Only brief mention can be made here regarding the examination of the firing hand to detect primer elements (lead are found on examination with the naked eye, e.g. blood droplets or tissue deposits on the firing hand ("backspatter" from the entrance wound), deposits of soot on thumb and index finger if these fingers are held around the muzzle end in order to place it on the chosen entrance site.

The presence of more than one gunshot wound does not generally preclude the possibility of self-infliction, provided that the ability to act was maintained until the last shot was fired. Even hitting the skull need not result in immediate unconsciousness, if only the frontal brain or a temporal lobe is injured and the transfer of kinetic energy of the bullet is limited. Even after gunshot wounds of the heart or the aorta the ability to act may continue for a short time, so that in case of a suicide it is possible to fire another shot into the chest or the head.

As far as a suicide is concerned, the following salient features may be repeated:

- women rarely shoot themselves;
- the weapon must always be present;
- the range must be within arm’s length, depending upon the nature of the weapon and excluding some mechanical device to fire the gun;
- sites of election are the temple, the neck, the mouth and the chest;
- shooting in anatomically inaccessible sites cannot be suicide;
- it is not true that suicides always shoot themselves in the head on the same side as their dominant hand.