




# FORENSIC MECHANICAL TRAUMATOLOGY

## MECHANICAL TRAUMATIC AGENTS

Mechanical traumatology covers the domain of injuries produced by various mechanical traumatic agents that possess a certain kinetic energy.

One of the main problems encountered in forensic practice is represented by the identification of the traumatic agent. A thorough observation and classification of traumatic lesions, both in live and deceased victims is required.

Traumatic agents can be classified in:

- 
- **Violent agents** 
    - with small surface (regular, irregular)
    - with large surface (plane, irregular)
  - **Sharp agents (point and / or blade)** 
    - stabbing
    - cutting
    - stabbing-cutting
    - cutting-lacerating
  - **Projectiles (bullets, pellets)**

- Small surface agents induce injuries on limited areas, sometimes reproducing the pattern of the contact surface.

- Large surface agents can produce fractures and organ crushes, proportional with their weight and impact speed.

- Stabbing instruments (needles, knitting needles etc.) are long and pointed. Their action results in tissue withdrawal from the centre of the wound to the periphery, depending on the object's diameter.

- Cutting instruments have sharp blades; injuries are produced by exercising pressure perpendicular on the skin, by combined, sliding-pressing motion, or by a tangential motion on the injured surface (partial or total skin detachments).

- The effects of stabbing-cutting instruments (pocket knives, knives, daggers, swords), are similar with the stabbing instruments, with the added sectioning effect of the blade.

- Cutting-lacerating instruments have a combined action, due to their cutting edge and to their weight. They will inflict incisions but mostly deep, complex, severe injuries, due to tissue laceration and crushing.

- Projectiles have a particular type of action, similar to that of stabbing objects, with the difference that bullets also have considerable impact speed and kinetic energy.

## TYPES OF PRIMARY INJURIES: GENERAL FEATURES, CLASSIFICATION

Primary injuries are the consequence of the interaction between violent agents and the impact area on the body. The morphological features of these injuries are in direct relation with a series of factors, such as:

- ❖ nature
- ❖ shape
- ❖ size
- ❖ weight
- ❖ impact speed
- ❖ kinetic energy of the traumatic agent.

Regardless if the victim is alive or deceased, an accurate description of all injuries is of paramount importance for the medico-legal practice. In describing the injuries, one should include the following elements:

- ☐ the type of lesion
- ☐ its location
- ☐ shape
- ☐ sizes
- ☐ colour
- ☐ the inclination of the main axis
- ☐ the aspect of the margins and angles
- ☐ the profile
- ☐ the presence or absence of haemorrhages, foreign objects
- ☐ the state of the neighbouring tissues.

- a. The type of injury** – bruise, abrasion, wound etc;
- b. The location of the injury** – starting with the general location (right superior limb, face, scalp etc), then specifying the exact location by using anatomical structures; the use of anatomical diagrams proves useful;
- c. The shape** – is important for the identification of the violent agent. Clear-shaped injuries should be simply described as various geometric forms - circular, triangular, semicircular (crescentic) etc. Other injuries should be labelled irregular.
- d. The sizes** – The size of an injury can be determined with any measuring instrument;
- e. The colour** – is important in appreciating the age of the injury;
- f. The direction (the axis inclination)** – indicates the direction of impact;
- g. The margins and angles** – are especially important in the description of wounds, for the identification of the violent agent;
- h. The profile of the injury** – is useful in the presence of an inflammatory process, a haematoma or a displaced fracture.
- i. The presence or absence of haemorrhages** – indicates the age of the injury;
- j. The presence of foreign bodies** – indicates the nature of the object or the mechanism of the injury;
- k. The aspect of surrounding tissues** – can also give indications about the weapon.

The description of all injuries is followed by other elements, useful for the investigating team, such as:

***The type of injuries and the nature of the trauma*** – bruise, wound, laceration

***The age of the injuries*** – fresh injuries do not present the typical signs of healing.

In a live victim, an abrasion remains moist until the cuticle forms. The cuticle takes a between a few days and two weeks to organise and then it detaches leaving a pinkish, intact skin. Post-mortem the cuticle does not form and the abrasion becomes brownish, parchment-like.

***The characteristics of the agent and its action*** –the particularities of the traumatising object can be estimated after a thorough examination of the injuries.

***The duration of the medical treatment*** – establishing the period of medical treatment is extremely important because depending on it, the crime act can be defined from the juridical point of view.

***Possible complications*** – it is useful to appreciate the prognostic of the injuries and the possibility of complications.

***The causality report*** between injuries and death is very important, and if this connection is direct, indirect or concurrent.

The following classification (Nanes), is very suitable for the forensic practice, because it offers the possibility of easily identifying the traumatizing object and the lesional mechanism:

***A. Injuries without skin discontinuity (contusive injuries)***

- the skin irritation (traumatic congestion)
- the bruise
- the haematoma
- the muscular contusion (rupture)

***B. Injuries with skin discontinuity***

- ❑ the abrasion
- ❑ the wound
- ❑ the laceration
- ❑ the stabbed wound
- ❑ the stabbed – cut wound
- ❑ the firearm wound (orificial)
- ❑ crushes and dilacerations
- ❑ traumatic amputations

***C. Osteo-articular injuries (sprains, luxations, fractures)***

***D. Internal organs injuries (wounds, ruptures crushes, dilacerations)***

***E. Vascular injuries (arterial, venous)***

***F. Nervous injuries (meningo-cerebral, medullar, of the peripheral nerves)***

***G. Particular injuries (dental injuries, hair pulling)***

## **INJURIES WITHOUT SKIN DISCONTINUITY**

### **1. TRANSITORY INJURIES (THE SKIN IRRITATION)**

Also known as traumatic congestion, the skin irritation is a transitory injury, result of a minimal contusion, followed by local vascular dilation. The red marks indicate a traumatism, for example the trace of a palm on a child's face or gluteal region should be photographed immediately because it will disappear an hour after the incident.

### **2. THE BRUISE**

The bruises are injuries resulting from an escape of blood that infiltrated the neighbouring tissues.

#### **2.1. The traumatic mechanism of the bruise**

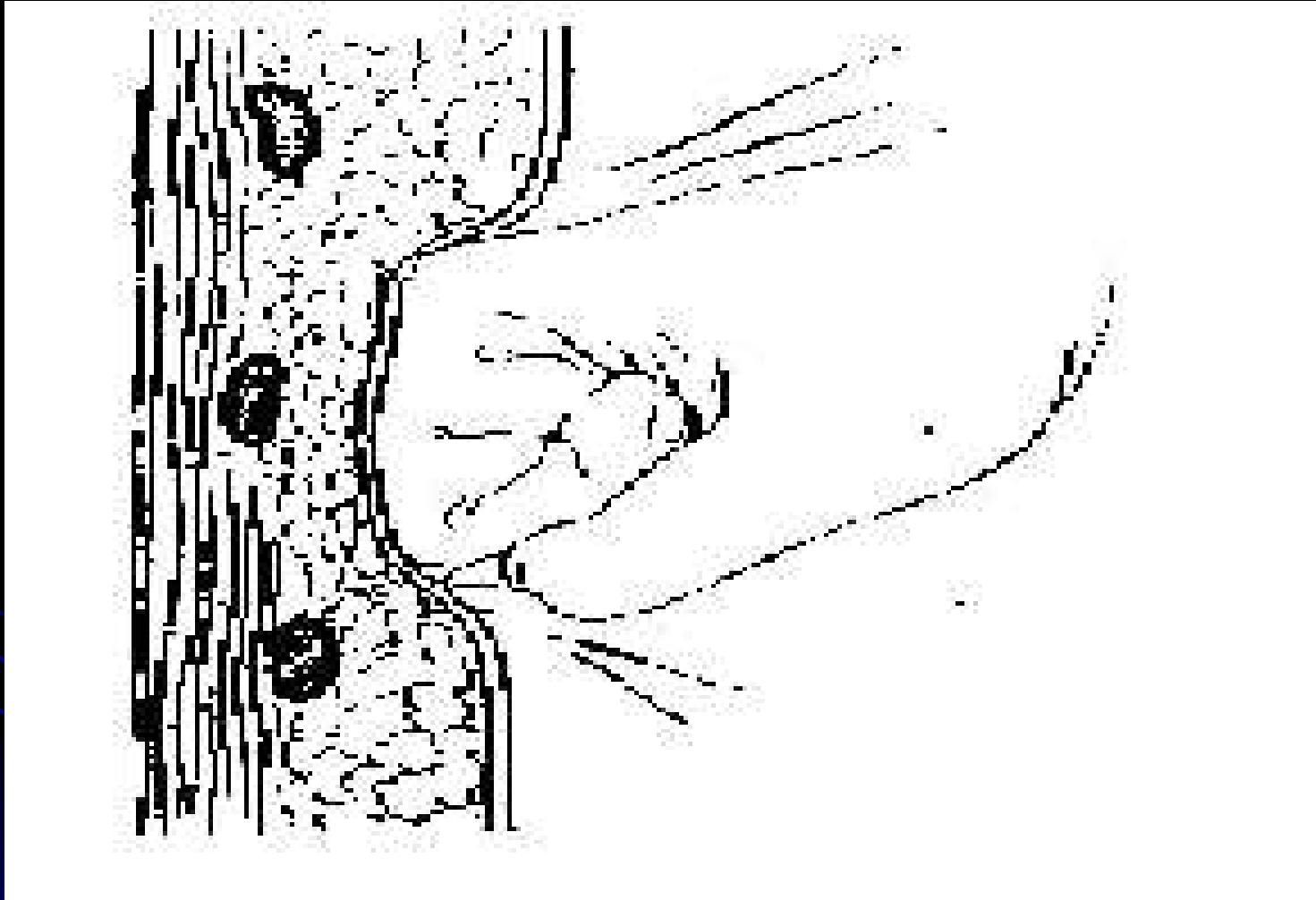
All contusive injuries have two main lesional mechanisms:

- either the violent object in motion hits a bodily region (active contusion);
- the victim's body in motion is projected against a fix rough object or plane (passive contusion).

The result is the rupture of the small vessels under the intact skin and the infiltration of the blood in the neighbouring soft tissues, under the influence of the cardiac pump.

This means that bruises can only constitute in living subjects.

The escaped blood will clot partially or totally and will become adhesive to the injured tissues, so it cannot be washed of.



**The mechanism of the bruise**



## 2.2. The macroscopic aspect

After a few hours, the post-traumatic changes become visible on the skin, initially as dark- red spots. There are multiple factors that influence the aspect of the bruise.

**The traumatic agent:** The shape of the bruise sometimes describes the shape of the agent, but it also depends on the anatomical region.

**The personal history:** age atherosclerosis, haemorrhagic disorders (haemophilia), severe hepatic failure, can often determine massive bruising after minor trauma.

**The topography of the bruise:** Bruises can be superficial (coetaneous, mucous, conjunctival) or more profound.

## 2.3. The colour of the bruise

The changes of coloration correspond to the degree of haemoglobin degradation.

The chromatic changes of bruises are a clear indication for their age:

- 1 day – red-bluish
- 2 days – dark-violet
- 3 days – brown-violet
- 6-7 days – greenish
- 10-12 days – yellowish

Bruises gradually fade away; the fading speed depends on the size of the bruise and the quantity of escaped blood.

It completely disappears in 17-25 days.

## **2.4. The migration of the escaped blood**

There are situations in which the bruise can appear at a distance from the injured area. This blood migration takes place in 4-5 days.

## **2.5. The histological aspect of bruises**

The microscopic examination of bruised tissue reveals two fundamental elements:

- the disappearance of tissular architecture, with fragments of more resistant tissue (vascular wall, aponeuroses, tendons, nerves);
- the replacement of anatomical structures with a mass of red cells (haemorrhage), incorporated in a tissular network (blood infiltration) and accompanied by a fibrin network (coagulation).

The escaped blood that infiltrates the tissues undergoes progressive changes that are responsible for the colour changes.

## **2.6. The topography and the significance of bruises**

Bruises are the expression of an injury, with reservations regarding a pre-existing pathological entity (vascular fragility, coagulation disorders etc.).

The size of a bruise is not always in direct correlation with the severity of the blow. In live victims a small bruise suggests a mild injury, while in a cadaver it may be the result of a heavy blow, if death occurred soon after the trauma.

Some bodily regions develop bruises faster than others, depending on their vascularisation and the density of the subjacent tissues.

In areas with corresponding bony structures and lax soft tissues (face) a relatively mild injury can determine a large, swelled bruise, especially around the eyes.

Some bruises can offer information about the traumatic agent.

Biting with a stick (or other cylindrical object) leaves parallel, “tram-track” bruises.

Other bruises are patterned, reproducing textile texture. This is the case of injuries inflicted on areas covered with clothing, or if the clothes are torn and twisted on the skin.

Another type of bruising can be seen in ligature strangulations, as linear stripes.

Other significant bruises are produced by finger pressure or grabbing; they are circular, oval or crescentic, with a 2 cm diameter.

When sexual assault is suspected, bruises are usually situated on thighs and on the inner side of the knees; they are the result of forceful spreading of the victim’s lower limbs.

Other bruises can be found on the neck, breasts and other bodily regions.

Usually bruises do not require medical treatment, except for the cases in which they are widely spread and accompanied by oedema.

In these cases 1-3 days of medical treatment can be given.

## 2.7. The differential diagnosis of bruises

Bruises can be mistaken with melanotic naevi and with the normal transversal lumbar striations of the teenagers.

Haemorrhagic purpurae in elderly subjects or in subjects with coagulation disorders are less contoured and wide.

Cyanosis can also be mistaken with bruises.

In cadavers bruises can be confounded with livor mortis, especially when they are superposed to the bruised area.

The differential diagnosis is made by performing transversal, incisions in the area and washing the section surface with water.

In case of bruising, the haemorrhagic infiltration of the tissues persists, while in lividities the infiltration is absent, the blood is liquid and disappears.

### **3. THE HAEMATOMA**

The haematoma is a post-contusive injury, represented by a blood collection in a newly formed cavity, usually located in the lax conjunctive tissue. The accumulated blood can be totally or partially clotted.

The traumatic mechanism is similar to the bruise with the difference that the calibre of the injured blood vessel is larger and the blood accumulation is bigger and more profound.

The haematoma is result of the direct traumatic action on the vessel due to its strong compression between two rough planes (the traumatic agent and the bony plane).

Superficial haematomas can determine external swelling and the respective skin area can also be bruised and sometimes fluctuant.

If the evolution is favourable, the haematoma slowly resorbs in 4-5 weeks. Large, non-evacuated haematomas can encapsulate in time. The result is a cavity with haematic content, surrounded by a conjunctive wall.

### **4. THE MUSCULAR CONTUSION**

Heavy blows can often produce crushes or dilacerations of muscular mass. The clinical findings include intense local pain and a certain degree of functional impotence.

In case of complete rupture, the muscular extremities retract so an excavation will appear between them; it is accompanied by severe haemorrhage and a large secondary haematoma.

## **4. INJURIES WITH SKIN DISCONTINUITY**

### **1. THE ABRASION**

The abrasion is an injury that only affects the superficial part of the skin.

It is the result of combined pressure and abrasion, either by a moving agent (sharp, cutting or rugged), or by the dragging of the injured area on an irregular rough plane.

The abrasion is represented by the decollation of the epiderma of the derma; in this case there is no bleeding and the surface of the injury is moist due to the lymphatic secretion.

If the dermal papillae are also interested, a thin layer haemorrhage is present. The blood that covers the abrasion dries and forms a red-brownish, parchment-like cuticle.

Abrasions can be:

- punctual
- linear
- polygonal, with regular or irregular shape, homogenous or non-homogenous surface.

In sexual assault abrasions are situated in the internal side of the thighs and around the genitalia.

Abrasions around the mouth and nose can suggest mechanical asphyxia (smothering).

**The shape of the abrasion can sometimes suggest the shape of the traumatic agent.**

**Crescentic abrasions on the neck are specific for hand strangulation. Other abrasions reproduce various patterns present on the surface of traumatic agents.**

**The characteristics of abrasions are more clear than those of bruises because once installed, abrasions do not spread on the surface or depth.**

**The evolutive stages of the abrasions are the following:**

- in the first 12 hours the surface of the abrasion is depressed lower than the peri-lesional surface; it is first moist and gradually dries;**
- after 24-48 hours the cuticle forms; it is brown-yellowish (plasma) in superficial abrasions or brown-reddish (blood) in the profound ones. The cuticle raises and finally it heaps up;**
- after 3-4 days the detachment of the cuticle starts, from the periphery to the centre;**
- after 7-12 days it is completely detached.**
- after 7-15 days a smooth, pinkish scar remains and in time the skin will regain its normal colour.**



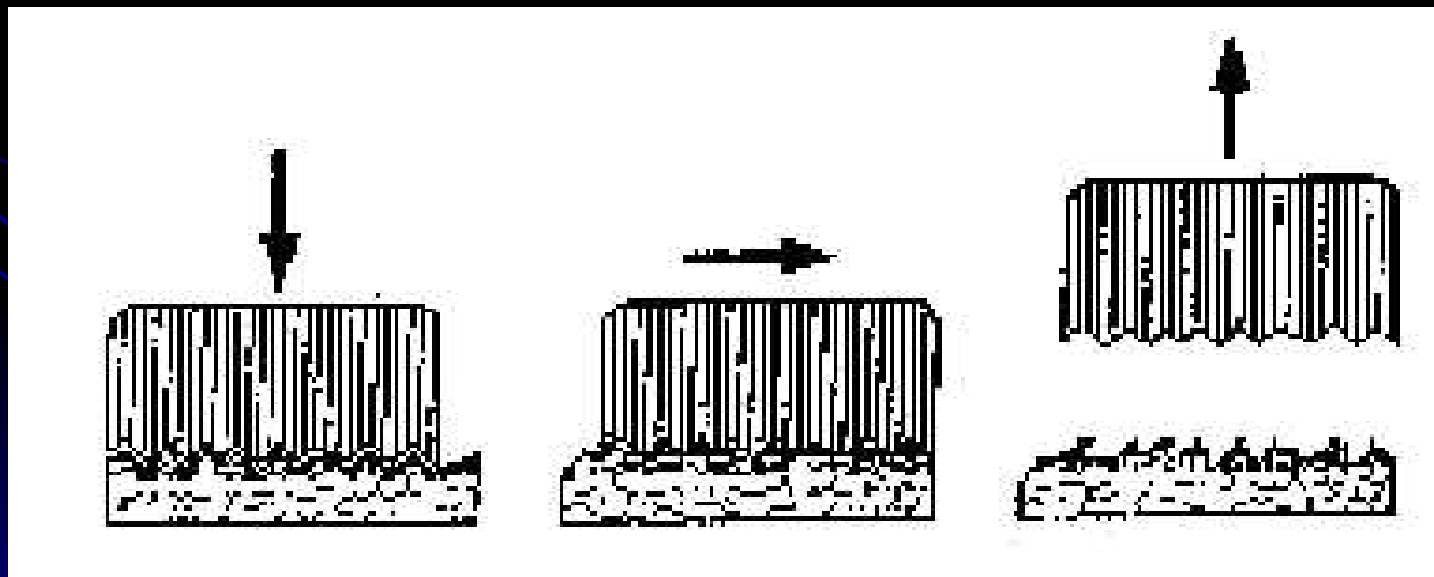
Microscopically after 3-6 hours there is leukocyte infiltration, accompanied by oedema in the injured chorion.

Six hours after constituting, the leukocyte infiltration is more intense and the cuticle is formed of dry necrotic tissue, infiltrated with leucocytes and deposits of destroyed red cells.

The differential diagnosis is made with the post-mortem tegument wounds caused by skin dehydration.

The folding of one end of a linear abrasion indicates the direction of the injury.

Abrasions may require 2-3 days of medical treatment, if no complications appear (local or general infections).



**The traumatic mechanism in abrasions**



## 2. THE WOUNDS

A wound is a discontinuity of the skin or a mucous membrane, interesting also the subjacent tissues.

### 2.1. The laceration (contusive wound)

Lacerations are violent injuries characterized by an irregular destruction of tissues, with the tendency to enlargement, due to the retraction of muscular and elastic fibres.

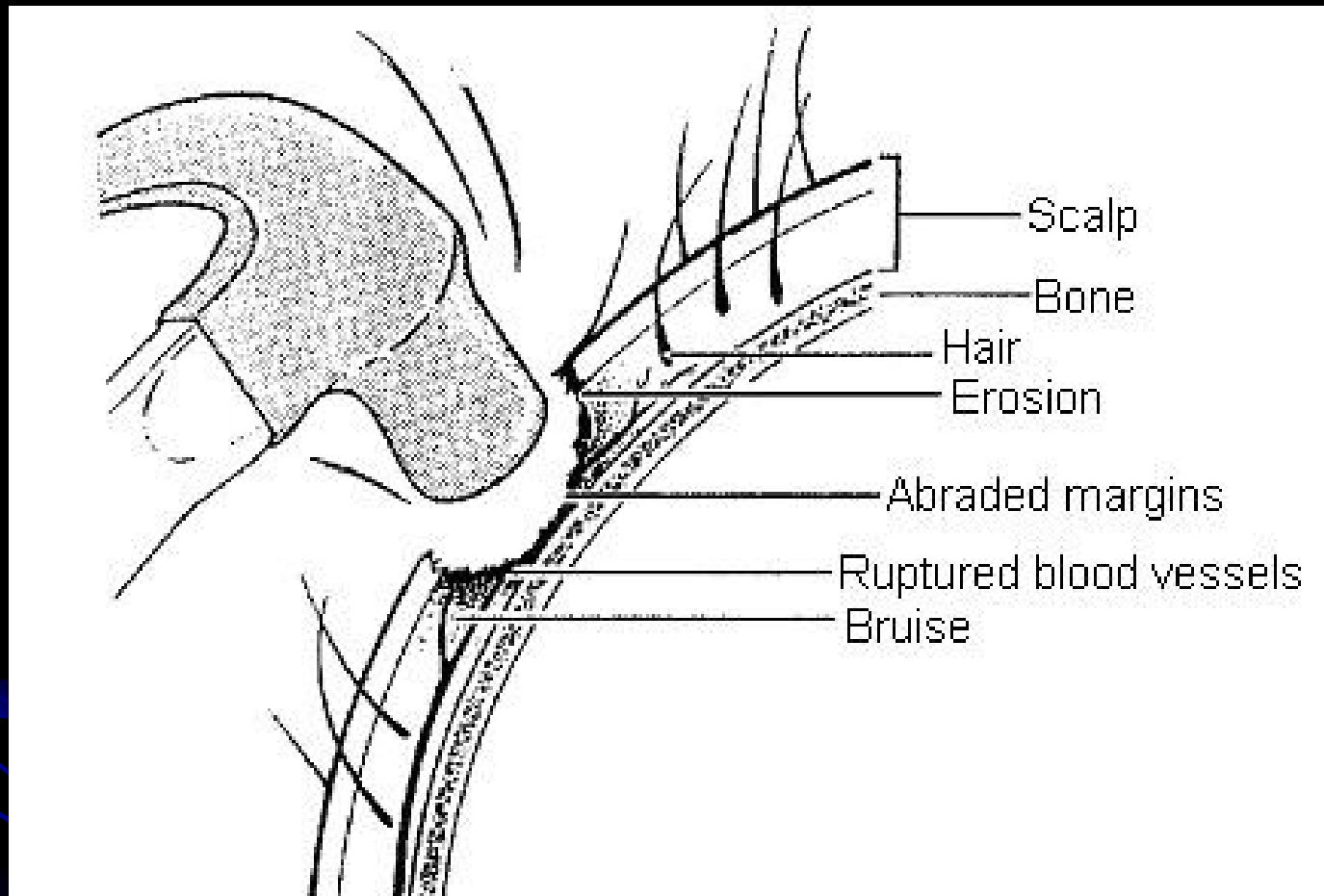
The laceration is produced by the direct action of a blunt object (active blow) or by a passive mechanism (falling).

Lacerations usually have irregular, star-like shapes. Their contour can sometimes suggest the shape of the traumatic agent. For example, a blow on the scalp with the round edge of a hammer determines a crescentic injury; when the contact surface of the object is rectangular, like the blunt edge of an axe, its margins will produce a three-corner laceration. Star-shaped lacerations can also suggest the shape and the number of edges of the agent.

Its margins are torn, rugged, anfractuous, detached of the profound planes and the extremities are more superficial. The margins can be destroyed by the impact force which has a scissoring effect on the skin.

The tearing of the skin in the moment of impact can produce a marginal abrasion area.

The bruised and abrasion margins of a laceration offer important information so they must be thoroughly analysed, even with a magnifying glass.



**The traumatic mechanism of the laceration**

The floor of the laceration is depressed, anfractuous, often covered by coetaneous bridges that connect the margins of the laceration.

Blood vessels, nerves and other tissular bridges can be visualized.

In some circumstances (skin stretched on a bony surface – orbit, the tibial crest) the laceration can be linear but a thorough examination will prove its irregular aspect, the torn margins, the tissular bridges etc.

- ✳ After haemostasis the surface of the laceration covers with clotted blood; the dry blood forms a haematic cuticle.
- ✳ After 4-5 days, the depressed, lacerated area begins to fill.
- ✳ The progressive contraction of the laceration reduces its initial size to one third in 8-10 days.
- ✳ Finally epiderma will cover the area, with a permanent scar.

The differential diagnosis is made especially with the cut wound, especially when situated on a superficial bony surface.

Small lacerations with good, natural evolution require 4-6 days of medical treatment.

## 2.2. The stabbed wound

Stabbing agents create wounds with small orifice but with profound trajectory.

The lesional mechanism of most stabbed wounds consists of the stabbing and distancing of the coetaneous elastic fibres, sometimes with hardly perceptible external expression.

The degree of tissular dislocation depends on the object's diameter. The tissular rupture takes place only if the tissular elasticity is defeated.

The morphology of the stabbed wound depends on the nature of the instrument and the affected region.

If produced with a **small diameter object**, the stabbed wound has the external appearance of a reddish dot and the trajectory is thin and reddish. Unless they interest vital organs (the heart), these wounds are harmless.

**Larger calibre agents** distance the elastic fibres and by rupturing and tearing they form slit-like, more or less prolonged orifices with symmetric margins (buttonhole), with no resemblance to the agent.

The stabbed wound is usually smaller on the skin than in depth, because the elasticity of the skin determines the return to the initial disposition.

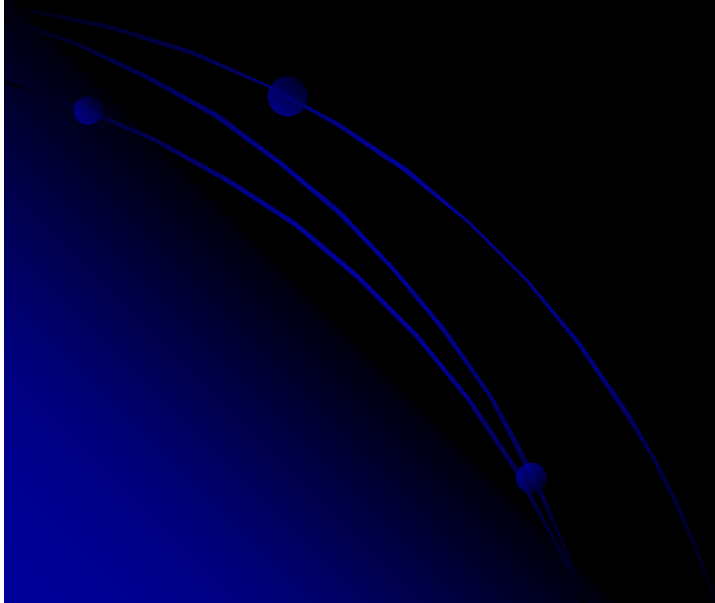
The trajectory or the channel is usually linear.

If inflicted on a bony surface, the stabbed wound can reproduce the shape and the real size of the instrument.

On the skull only the orifice in the outer table reproduces the size and shape of the object; the inner table splits so the injury is larger than the object

The differential diagnosis of the stabbed wound is usually done with the stabbed-cut wound; the latter has sharper angles, regular margins and fine, linear abrasions at the extremities.

The period of medical treatment varies, depending on the affected area and organs, the depth of the wound, complication etc.



### **2.3. The cut wound**

Cut wounds are made with cutting instruments; they produce discontinuities as they slide along the skin, sectioning and separating the tissues.

The morphology of the cut wound is mainly characterised by the fact that its length is much bigger than its depth. The margins are usually straight, without accompanying bruises or abrasions.

In depth the section surface is plane; blood vessels and nerves suffer transversal cuts, which can lead to important bleeding.

If the instrument is handled with the cutting edge perpendicular on the skin, the external aspect of the wound is linear, with perfectly straight margins.

The length of the wound is in direct relation with the mechanism: simple pressure on the skin or a combined, pressure-sliding movement.

The dehiscence of the cut wound depends on the elasticity of the involved tissues.

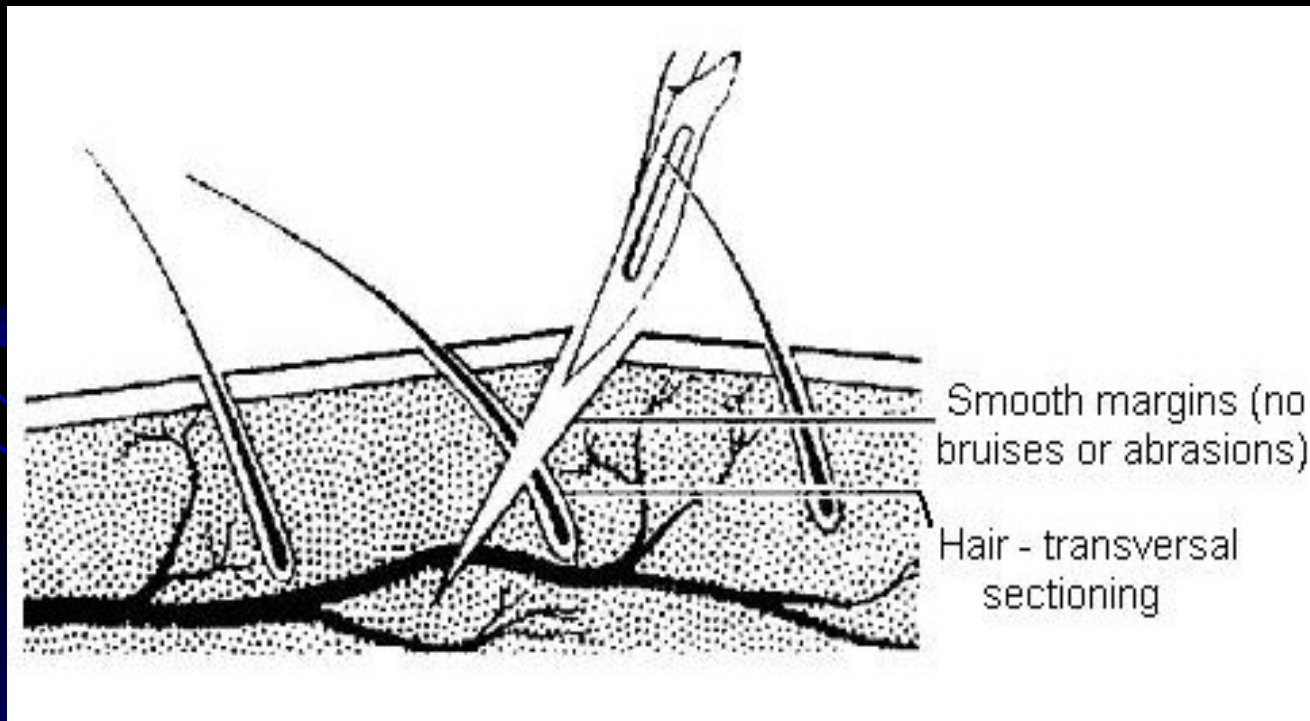
If the incision is parallel with the elastic fibres, the wound is fusiform, with close margins.

Oblique or perpendicular incisions provoke wounds with separated margins; also when an aponeurosis is interested, the dehiscence is bigger. For a more accurate measurement of the length on cadavers, the margins must be manually approached.

The depth of the wound depends on the exercised pressure, the sharpness and inclination of the instrument and the resistance of the tissues.

Usually the initial angle is more regular and deeper while the terminal portion is more superficial.

At one or both ends the wound can also present a linear abrasion. If this abrasion is only present at one end or is longer at one end, than that end is most probably the final part; this information is important for the direction of the cut.



**The mechanism of the cut wound**



The location of cut wounds is predominantly on the head and neck and if the assault has sexual connotations, wounds can also appear on the breasts and around the genitalia (most frequently in homicide cases).

The differential diagnosis is usually made with the laceration, mostly if the cutting instrument has blunt, irregular or dentate-serrated edges.

The difference must also be made with the cut-stabbed wound that has similar external morphology but has a deep trajectory channel, longer than the external wound.

If situated on the fingers and forearms, cut wounds might be defence injuries, produced during the defence attempt of the victim.

Suicide cuts are often parallel, multiple, mostly superficial (attempt cuts), located on the internal side of the wrists, forearms or on the lateral sides of the neck.

In lethal cases, the attempt wounds will be associated with a more profound wound that involves vital structures and is responsible for the lethal ending.



## ***2.4. The stabbed-cut wounds***

The stabbed-cut wounds are produced with instruments that affect tissues and organs in depth, on a longitudinal axe, due to their kinetic force and to the exercised compression (knives, pocket knives, daggers, bayonets etc).

These instruments have both a sharp point and a sharp blade (or blades) so the wound will have the combined characteristics of stabbed and of cut wounds.

The characteristic feature of these penetrating wounds is the fact that their depth is bigger then the length or width.

The morphology of cut-stabbed wounds varies with the shape and characteristics of the traumatic agent.

Double-bladed instruments determine oval wounds, with narrow angles and straight margins.

Wounds produced with single-bladed instruments (kitchen knife) have one sharp angle and one irregular, „fish-tail” angle, corresponding to the sharp and the blunt blade, respectively.

The external aspect of the wound offers valuable information about the instrument:

- Double-bladed instruments create wounds similar to the cut ones: linear, with straight margins and sharp angles;
- Single-bladed instruments produce wounds with one rounded or irregular angle, corresponding to the blunt margin;
- There are also instruments with three or four sharp blades; they will inflict star-like wounds.

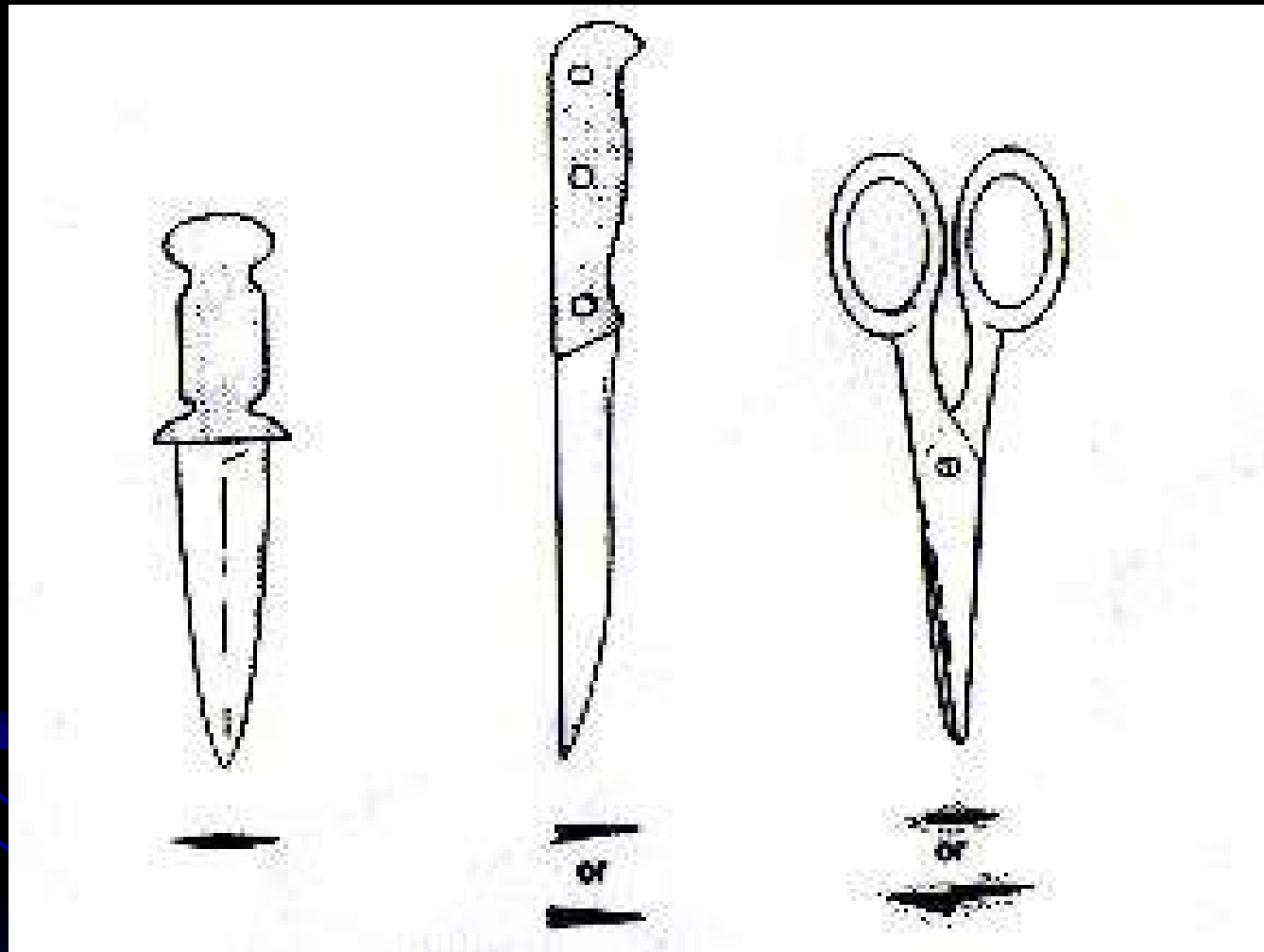
If the instrument is also twisted while extracted, the aspect of the margins and angles change accordingly. After the blade is drawn out, the skin has a natural tendency to retract. This is why the length of the wound can be smaller and the depth bigger than the dimensions of the agent.

The length of the wound corresponds to the width of the blade only if the instrument is both introduced and extracted perpendicularly; otherwise, the wound will be longer than the width of the blade.

The in-depth trajectory channel indicates the direction of the blow. Its length is usually smaller than the length of the instrument.

The tissue elasticity makes the width of the channel generally smaller than the width of the instrument.

If a cutting-stabbing instrument penetrates a flat bone, the width of the bony injury is equal with the width of the blade at the level of maximum penetration. If stabbing is profound death can be sudden, due to massive haemorrhage and occasionally due to gas embolism.



**Cut-stabbed wounds**

## **2.5. The lacerated wound**

Lacerating agents have a less sharp blade / edge and higher volume and weight (axe, shovel, spade, and sword).

Their kinetic energy at impact is high so lacerations will be profound.

The aspect of a lacerated wound is irregular, with skin detachments or even mutilations. They are a combination between superficial cuts and deep laceration.

The whole wound is often prism-shaped and it sometimes reproduced the instrument.

The width of the lacerated wounds depends on the width, weight and kinetic energy of the instrument, the inclination of the blow and the tissue resistance.

Their severity is in direct relation with their depth, possible injuries of internal organs, haemorrhages and, later on, infections.

The differential diagnosis is usually made with the contusive and the cut wound.

## **2.6. Firearm wounds**

The firearm wound is the consequence of the projectile shooting. The wounds are orifices with particular characteristic.

### **3. CRUSHES AND DILACERATIONS**

Crushes and dilacerations result in total or partial destructions of tissular integrity. They are characterised by the total loss of anatomical structure – an amorphous mass. The mechanisms are various: falling (striking), hitting-projecting, compression between two rough planes (run-over, crushing). The injuries interest soft tissues (crushes and dilacerations), bony structures (comminute fractures) and internal organs (especially parenchymal, less often cavitory).

### **4. TRAUMATIC AMPUTATIONS (SECTIONING)**

Traumatic amputations are the total separations of various segments of the body. There are two kinds of traumatic amputations in the forensic practice: accidental and criminal.

Accidental amputations are various, depending on the nature and the severity of the incident. Train or tram accidents are a frequent cause.

Criminal amputations can be defensive or offensive. Offensive amputations on live victims can originate in rage, sadism or psychiatric disorders; They can interest smaller (fingers, nose, ears) or larger bodily parts and can be inflicted with larger or smaller cutting, cutting-stabbing or lacerating instruments. Defensive amputations are usually performed on cadavers, with the purpose of concealing the body and, thus, the crime.

The quality of the sections can give some indications regarding the skills of the author. They can be irregular, negligent, or straight, regular, respecting the anatomical structures.

## OSTEO-ARTICULAR INJURIES

The most representative osteo-articular injuries are the fractures.

They are partial or total bony discontinuities and can be produced during any traumatism that defeats the resistance of the bony tissue.

In long bones, fractures are either the result of direct blows with blunt objects, or the result of indirect mechanisms:

- ❑ sudden push on a bony extremity;
- ❑ diaphysis curving under pressure on one or both extremities;
- ❑ torsion of one extremity;
- ❑ pulling mechanism.

A skull vault fracture requires a force of approximately 60 kg/cm<sup>2</sup> to defeat the bone resistance and elasticity.

A progressive compression can determine, depending on its intensity: a blood escape in the diploe (bony bruise), fissure of one table or an incomplete fracture, linear or comminuted.

Fractures can be classified according to various criteria:

- a. **Location** – diaphysal, diaphyso-epiphysal, metaphysal
- b. **The disposition of the fractured extremities**
  - closed (without displacement)
  - open (with displacement)
- c. **The morphology**

## ***Classification from morphological point of view***

### **1. Incomplete fractures**

- partial (interesting only part of the bone – e.g. the convexity of a rib)
- fissures (interesting only one table, or parallel with the longitudinal axis of the bone)
- trabecular ruptures (situated intra- or juxta-articular)
- depression of one bony table (flat bones) or of a limited portion of a bone (short bones);

### **2. Complete fractures**

- simple (transversal, oblique, spiroidal, „Y”-, ”T”- or butterfly-shaped);
- multiple (double, triple, quadruple);
- comminuted;
- orificial (due to firearm projectiles or other penetrating agents).

The elements of positive diagnosis for fractures are:

- the abnormal mobility of a segment
- the presence of bony crepitations at palpation and mobilisation.

The certainty element that indicates the presence and the location of a fracture is the radiological examination.

The duration of necessary medical treatment depends on the fractured bone, the type and the extent of the fracture, the presence or absence of bony displacement, the natural reactivity of the body etc.



## INJURIES OF THE INTERNAL ORGANS

These are thoracic, abdominal or meningo-cerebral injuries.

In thoracic injuries there are costal injuries, often multiple, with the depression of the sterno-costal plateau.

They can associate with pleural injuries (with uni- or bilateral haemo-thorax, pneumo-thorax or haemo-pneumo-thorax) and injuries to the pulmonary parenchyma.

The parenchymal lesions are either vascular, or bronchiolar and alveolar, with the apparition of airy cavities and interstitial emphysema.

Violent thoracic contusions are prone to induce cardiac injuries like haemo-pericardium, sub-endocardic, valvular ruptures or even myocardial ruptures.

In the mediastinum, ruptures of the large blood vessels from their cardiac insertion or the pulmonary hilum, and tracheal or bronchial ruptures can be observed.

In abdominal contusions the most frequently injured organ is the liver. Parenchymal and capsular hepatic ruptures with isolated haemorrhages or sub-serous haematomas are present.



**The spleen can be ruptured, with extreme haemorrhage and quick death or with a delayed („ sequential”) rupture.**

**Cavity organs are less susceptible to injuries. The stomach is more often exposed, especially when it is full. The result is either a rupture of the tunicae, or a variable haemorrhage, depending on the size and location of the rupture.**

**Depending on the intensity of the trauma, the kidneys can present subcortical infiltrates, cortical or medullar haemorrhages; haematuria appears if they communicate with the renal tubes or the renal pelvis.**

**Contusions of the pregnant uterus rarely determine abortion in the first months of pregnancy; abortion is more frequent after the uterus becomes an abdominal organ**

## VASCULAR INJURIES

The main consequence of vascular injuries is the haemorrhage (internal or external); their intensity will be in direct relation with the type of vessel (artery or vein), its calibre and the nature of the injury.

Contusive injuries produce vascular crushes, both by direct impact compression on a subjacent rough plane, and by indirect mechanisms such as the effect of luxated or fractured bony fragments. The consequence of the vascular contusions can be the haemorrhage inside the vascular wall, with consequent haemorrhagical infiltrate.

Sharp agents usually produce severe vascular damage. In venous haemorrhages the blood is red-blackish and the haemorrhagic flow is continuous, with low pressure. If major veins are affected, the haemorrhage can be dramatical and death can onset rapidly.

The arterial traumatisms can lead to internal or external haemorrhages with red blood and discontinuous flow, due to the increased pressure during the cardiac contractions.

In some cases the haemorrhage appears after a free interval, for example due to the reactive post-traumatic spleen contraction.

Regardless of the nature of the injured vessel, the blood can accumulate in various natural cavities, forming haemorrhagic collections (haemo-thorax, haemo-pericardium, haemo-peritoneum etc.) or erupting in the exterior (external haemorrhages).

## INJURIES OF THE PERIPHERAL NERVES

The peripheral nerves can suffer direct and indirect injuries.

The direct injuries result in nerve sectioning during an open traumatism, or nerve compression and rupture during contusive traumatisms (sectioning, rupture, crushing).

Indirect injuries are secondary to vascular injuries with ischemic consequences.

The consequences of nervous injuries can be sensitivity or motility, vascular motility or trophic disorders.

## THE EFFECTS OF TRAUMATIC INJURIES

- the traumatic shock
- the hemorrhage
- the infection
- the embolism
  - *the fat embolism*
  - *the gas embolism*
  - *the pulmonary thromboembolism*
  - *the foreign body embolism*
  - *the liquor amnii embolism*
- the adult respiratory distress syndrome
- the suprarenal haemorrhage



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