Classification and management of wound, principle of wound healing, haemorrhage and bleeding control

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WOUND It is a circumscribed injury which is caused by an external force and it can involve any tissue or organ. (surgical and traumatic/accidental)

INJURY It is caused by external noxa that causes cellular and/or tissue trauma and dysfunction. External noxa: mechanical, chemical, radiation or combination of them.
The role of the skin

- First anatomical barrier from pathogens
- Damage → quick and effective protective mechanism and regeneration

Result:
- Scar tissue – structure
- Tensile strength ↓
- Barrier =
WOUND

- mild
- severe
- lethal

- acute - An acute wound is an injury to the skin that occurs suddenly rather than over time. It heals at a predictable and expected rate according to the normal wound healing process.

- chronic - A chronic wound develops when any acute wound fails to heal in the expected time frame for that type of wound, which might be a couple of weeks or up e.g. ulcer, decubitus, burn wound.
## Wound types

<table>
<thead>
<tr>
<th>Simple wound</th>
<th>Compound wound</th>
</tr>
</thead>
<tbody>
<tr>
<td>skin</td>
<td>any other tissues</td>
</tr>
<tr>
<td>mucous membrane</td>
<td></td>
</tr>
<tr>
<td>subcutaneous tissue</td>
<td></td>
</tr>
<tr>
<td>superficial fascia</td>
<td></td>
</tr>
<tr>
<td>partially the muscle</td>
<td></td>
</tr>
</tbody>
</table>

- Simple wound: skin, mucous membrane, subcutaneous tissue, superficial fascia, partially the muscle
- Compound wound: any other tissues
The mnemonic ABCDE is used to remember the order of assessment with the purpose to treat first that kills first.

- **A**: Airway and C-spine stabilization
- **B**: Breathing
- **C**: Circulation
- **D**: Disability
- **E**: Environment and Exposure
Wound management - anamnesis

- When and where did the injury happen?
- Alcohol and drug consumption
- What did cause the wound?
- The circumstances of the injury
- Other diseases e.g. diabetes mellitus, tumour, atherosclerosis, allergy
- The state of patient’s vaccination against Tetanus
- Prevention of rabies
- The applied first-aid
Tetanus

The mortality rate is approximately 20%. Tetanus is an illness preventable through primary immunization and regular booster shots. Groups that may have missed primary immunization include elderly patients.

<table>
<thead>
<tr>
<th>wound</th>
<th>Tetanus infection not suspected</th>
<th>Tetanus infection suspected</th>
</tr>
</thead>
<tbody>
<tr>
<td>time between injury-wound care</td>
<td>6 h &gt;</td>
<td>6 h &lt;</td>
</tr>
<tr>
<td>type</td>
<td>linear</td>
<td>crushed, torn</td>
</tr>
<tr>
<td>depth</td>
<td>1 cm ≥</td>
<td>1 cm &lt;</td>
</tr>
<tr>
<td>circumstances</td>
<td>sharp object</td>
<td>thermal, punctured, shot, bite</td>
</tr>
</tbody>
</table>
**Tetanus**

Clostridium tetani inactivated toxin
1 ml, im.

**Active immunization:**

<table>
<thead>
<tr>
<th>Status</th>
<th>Active immunization YES/NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>No primary immunization, no booster shot or not known</td>
<td>YES</td>
</tr>
<tr>
<td>No primary immunization, active immunization 10 years&lt;</td>
<td>YES</td>
</tr>
<tr>
<td>No primary immunization, active immunization 10 years&gt;</td>
<td>NO</td>
</tr>
<tr>
<td>Has primary immunization, active immunization 10 years&lt;</td>
<td>YES</td>
</tr>
<tr>
<td>Has primary immunization, active immunization 10 years&gt;</td>
<td>NO</td>
</tr>
<tr>
<td>Has primary immunization, active immunization 10 years&gt;</td>
<td>YES</td>
</tr>
<tr>
<td>BUT extraordinary cases eg. serious wound, very dirty, head, significant blood loss</td>
<td>YES</td>
</tr>
</tbody>
</table>

**Passive immunization:**

Ig., 500-1000 NU, im.
Classification of the accidental wounds

1. Based on the origine

- **I. Mechanical:**
  - 1. Abraded wound (vulnus abrasum)
  - 2. Puncured wound (v. punctum)
  - 3. Incised wound (v. scissum)
  - 4. Cut wound (v. caesum)
  - 5. Crush wound (v. contusum)
  - 6. Torn wound (v. lacerum)
  - 7. Bite wound (v. morsum)
  - 8. Shot wound (v. sclopetarium)

- **II. Chemical:**
  - 1. Acid
  - 2. Base

- **III. Wounds caused by radiation**

- **IV. Wounds caused by thermal forces:**
  - 1. Burning
  - 2. Freezing

- **V. Special**
# Mechanical wounds

1.) **Abraded wound (v. abrasum)**

- Superficial part of the epidermal layer
- Blunt trauma
- Mild
- Good wound healing

2.) **Punctured wound (v. punctum)**

- Sharp-pointed object
- Seems negligible
- BUT
- Anaerobic infection
- Injury of big vessels, parenchimal organs, nerves
- In thorax - pneumothorax
- X-ray! – foreign body
- Wound healing process is bad.
### Mechanical wounds

<table>
<thead>
<tr>
<th>3.) Incised wound (v. scissum)</th>
<th>4.) Cut wound (v. caesum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Sharp object</td>
<td>- Sharp object + blunt additional force</td>
</tr>
<tr>
<td>- Wound edges – even, wound corner – narrowing</td>
<td>- More serious destruction</td>
</tr>
<tr>
<td>- No strong destruction but check the wound base</td>
<td>- Foreign body - textile</td>
</tr>
<tr>
<td>- Best healing</td>
<td>- Edges – even or uneven, open edges</td>
</tr>
<tr>
<td>- Surgical wound</td>
<td>- Bad wound healing</td>
</tr>
</tbody>
</table>
### Mechanical wounds

#### 5.) Crush wound
**(v. contusum)**
- Blunt force
- Pressure injury – connective tissue and fat
- Edges – uneven and torn
- Bleeding not remarkable
- In the wound cavity:
  - blood and destructed tissue
  - Wound stupor
  - Bad wound healing

#### 6.) Torn wound
**(v. lacerum)**
- Great tearing or pulling
- Incomplete or complete amputation
- Uneven wound edges, ragged wound wall
- Strong bleeding!
- Foreign body! Contamination
- Bad wound healing

*Note:* Crush wound and Torn wound are examples of Mechanical wounds.
7.) Shot wound (v. scolperatium)

- Close - burn injury
- Foreign materials (oil, metal, smut)

unjured tissue
necrobiotic zone (bleeding, thrombus, vessel destruction)
necrotic zone (died tissue)
slot tunel - foreign bodies

Slot tunel exploration!
8.) Bite wound (v. morsum)

- Damage depends on the teeth (animal) and the bite force
- Ragged wound
- Crushed tissue
- Torn
- Punctured
- Bone fracture
- Severe infected wound

- Prevention of rabies
- Tetanus profilaxis

**OPEN WOUND MANAGEMENT!**
Rabies

cat, dog – vaccination book
unknown animal or animal without vaccination
– start vaccination
human bite – hepatits, HIV

Rule of Verorab vaccination
- never vaccinated or the vaccination was more than 5 years ago
  4 doses Verorab:
  0 day: 2 doses
  7th day: 1 dose
  21st day: 1 dose
- If the patient has reduces immunity or in increased risk of infection
  6 doses Verorab:
  0 day: 2 doses
  3rd day: 1 dose
  7th day: 1 dose
  14th day: 1 dose
  28th day: 1 dose
- The vaccination was less than 5 years ago
  2 doses Verorab: 0 day: 1 dose, 3rd day: 1 dose
# The direction of the flap

<table>
<thead>
<tr>
<th>Distal</th>
<th>Proximal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flap necrosis</td>
<td>The wound healing is good</td>
</tr>
</tbody>
</table>
# Chemical wounds

<table>
<thead>
<tr>
<th>1.) Acid</th>
<th>2.) Base</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Protein precipitation</strong></td>
<td><strong>dissolved protein</strong></td>
</tr>
<tr>
<td>- in small concentration – irritate</td>
<td>- colliquative necrosis</td>
</tr>
<tr>
<td>- in large concentration – coagulation necrosis</td>
<td>- Necrotic tissue becomes liquified (cell and protein enzymatic lysis)</td>
</tr>
<tr>
<td>- Swallowed acid – chest pain, vomiting</td>
<td>- Swallowed base – pain, salivation, vomiting</td>
</tr>
<tr>
<td>- → aspiration of acid – glottis spasm*, oedema</td>
<td>- → aspiration of base – glottis spasm, oedema – serious oesophagus injury</td>
</tr>
<tr>
<td>- → stomach injury, perforation → shock, peritonitis</td>
<td>- → mucosal layer of stomach becomes gelationous, perforation</td>
</tr>
<tr>
<td>- → absorbed acid – acidosis, respiratory disorder, coma, renal failure</td>
<td></td>
</tr>
<tr>
<td><strong>MUST NOT INDUCE VOMITTING!</strong></td>
<td></td>
</tr>
<tr>
<td><strong>MUST NOT GIVE BASE OR MILK TO DRINK!</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Glottis spasm – sorry for the misunderstanding!
Symptoms and severity depend on:

- Amount of radiation
- Length of exposure
- Body part that was exposed

**Mild**: erythema, dermatitis, cystitis, nausea

**Severe**: fibrosis, ulcer

Symptoms may occur immediately, after a few days, or even as long as months.

**What part of the body is most sensitive during radiation sickness?**

bone marrow

gastrointestinal tract
1.) Burning (combustio)

Water and heat loss
Sepsis
Metabolic change! – toxemia

*Treatment, analgesia:*
Cooling – cold water and clean covering
Wound protection – infection
Tetanus profilaxis
Removal of bullas
Rehidration
Keep energy and protein homeostasis

- a – normal skin
- 1 - *1st degree* – superficial injury (epidermis) – redness, oedema (5-7 days)
- 2 – *2nd degree* – partial or deep partial thickness (epidermis+superficial or deep dermis) – redness, oedema, bullas (2-4 week)
- 3 – *3rd degree* – full thickness (epidermis + entire dermis)
- 4 – *4th degree* – (skin + subcutaneous tissue + muscle and bone)
Wounds caused by thermal forces

2.) Freezing (congelatio)

Severity depends on:
- Temperature
- Duration

Cold $\rightarrow$ vasoconstriction $\rightarrow$ thrombosis

Severity:
- Mild - redness
- Moderate - bullas
- Severe - gangrene

Treatment:
- rewarm – not only the frozen area but the whole body
## Exotic, poisonous animals

- Toxins, venom - toxicologist
- Skin necrosis, limb loss

<table>
<thead>
<tr>
<th>Envenomed foot</th>
<th>Special wounds</th>
<th>Exotic, poisonous animals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Classification of the wounds

2. According to the bacterial contamination

- **Clean wound** (A) – in operation, no inflammation
- **Clean-contaminated wound** – infected clean wound,
  respiratory, GI, urogenital system is opened under aseptic condition
  antibiotic profilaxis in high risk patients
- **Contaminated wound** (B) – septic operation
  the microorganisms involved in the infection was in the operation site before the operation,
  acute accidental wounds; perforation, fistula, abscess
  Betadin or physiological salt solution lavage,
  antibiotic profilaxis
- **Heavily contaminated wound** (C) – sever septic operation
  long time between the contamination and the wound care
  war wounds, gangrene, abscess, ileus, tissue necrosis, organ necrosis
The wound management

- **Temporary wound management (first aid)**
  - clean, hemostasis, covering

- **Final primary wound management**
  - clean, anaesthesia, excision, sutures
  - **ALWAYS:** thoracic cavity, abdominal wall or dura mater injury
  - **NEVER:** war injury, inflammation, contamination, foreign body, special jobs, bite, shot, deep punctured wound

- **Primary delayed suture (3-8 days)**
  - clean, wash – saline, cover
  - excision of wound edges, sutures
The wound management

- Early secondary wound closure (2 weeks)
  - after inflammation, necrosis – proliferation
  - anesthesia, refresh wound edges, suturing and draining

- Late secondary wound closure (4-6 weeks)
  - anesthesia, scar excision, suturing, draining
  - greater defect – plastic surgery
The surgical wound

- Surgical incision
- Stretch and fix
- Handling the scalpel
- Langer lines,
  Borges – relaxed skin tension lines (RSTL)
  wrinkle lines
- Skin edges
- Vessels and nerves
- Hemostasis

The wound edges

Handling the scalpel
The wound healing

- Hemostasis-inflammation
- Granulation-proliferation
- Remodelling
1. Hemostasis - inflammation

- Vasoconstriction
- Fibrin clot formation
- Proinflammatory cytokines and growth factors releasing
  - Vasodilatation
  - Infiltration PMNs, macrophages
  - Cytokines releasing
    - Angiogenesis
    - Fibroblast activation
    - B- and T-cells activation
    - Keratinocytes activation
    - Wound contraction

Molecular production of thrombocyte:
- Chemokines
- Proinflammatory cytokines
- Inflammatory lipids
- Anti- and proangiogen factors
1. Hemostasis - inflammation

- Debridement
- Phagocytosis
- Chemokins: IL-8, MCP-1

PMN

Growth factors and proinfl. citokines

Infiltr.

macrophages

Different growth factors

Cell proliferation
ECM synthesis
Angiogenesis
2. Granulation-proliferation

- fibroblast migration
- collagen deposition
- angiogenesis
- granulation tissue formation
- epithelisation
- contraction
Fibroblast migration and collagen deposition

TGF-β → fibroblasts

PDGF

thrombocytes, activated macrophages, endothelial cells, fibroblasts and smooth muscle cells

I., III. és V. type collagens, proteoglycans, fibronectin, other ECM elements
Angiogenesis

Epithelium, ECM

NO
VEGF

endothel cell proliferation, increased vessel permeability

FGF

endothel cell proliferation, differentiation, PA synthesis

Epithelization: Barrier function

Wound contraction: Myofibroblasts
3. Remodelling

- regression of many capillaries
- physical contraction – myofibroblasts
- collagen degeneration and synthetisation
- new epithelium
- tensile strength – max. 80%
Types of wound healing

- **Healing by primary intention**
  without any complications
  fibrin fibers cover the wound – protection
  ↓
  Linear wound healing

- **Healing by secondary intention**
  caused by infection, dehiscence, crush wound, surgical fault

**Difference:**
- granulation tissue
- inflammation phase
- the amount of fibrin and fibronectin
- wound shrinkage
Factors affecting wound healing

LOCAL

1. Infection:
   - Endotoxin → collagenase stimulation → Collagen degradation

2. Foreign body:
   - Elongation of inflammatory phase

3. Edema/elevated tissue pressure
4. Ischemia
   - These factors reduce blood supply.

Wound healing needs energy

- Glucose and oxygen supply ↑
- ATP production ↑
Factors affecting wound healing

**SYSTEMIC**

- **Age and gender**: inflammatory and proliferative phase! slower reepithelization
- **Diseases**
  - Sorbitol → vascular complication, Granulation, collagen level ↓
  - Infection, dehiscence, hematoma, seroma
- **Obesity**: Corticosteroid (reduce cell growing), cytostatics (reduce cell metabolism), NSAIDs (reduce blood supply), radiation (free radicals)
- **Medication**
  - Alcoholism and smoking
    - Neutrophil ↓ Phagocyte function ↓
  - Sepsis
    - Hemostasis, hemorheology ↓
  - Nutrition
    - Glucose, glutamin, vitamins, trace elements
Complications of wound healing

I. Early complications

- Seroma
- Hematoma
- Wound disruption
- Superficial wound infection
- Deep wound infection
- Mixed wound infection
1.) Seroma

- Filled with serous fluid, lymph or blood
- Fluctuation, swelling, redness, tenderness, subfebrility

**TREATMENT:**
- Smaller – spontaneous absorption
- Sterile puncture and compression
- Suction drain
- Surgical exploration
2.) Hematoma

- Bleeding, short drainage time, anticoagulant
- Risk of infection
- Swelling, fluctuation, pain, redness – symptoms similar to the infection

**TREATMENT**

- Smaller – spontaneous absorption
- Sterile puncture
- Surgical exploration
### Early complications of wound healing

#### 3.) Wound disruption

- Surgical error
- Increased intraabdominal pressure
- Wound infection
- Hypoproteinaemia

**TREATMENT**

- U-shaped sutures

<table>
<thead>
<tr>
<th>A. partial – dehiscencece</th>
<th>B. complete - disruption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Early complications of wound healing

## Superficial wound infection

<table>
<thead>
<tr>
<th>1.) Diffuse</th>
<th>2.) Localized</th>
</tr>
</thead>
<tbody>
<tr>
<td>eg. erysipelas</td>
<td>Eg. abscess</td>
</tr>
<tr>
<td>• Located below the skin</td>
<td>• Anywhere</td>
</tr>
</tbody>
</table>

**TREATMENT**

- Resting position
- Antibiotic
- Dermatological consultation

**TREATMENT**

- Surgical exploration
- Drainage
- X-ray examination
# Early complications of wound healing

## Deep wound infection

<table>
<thead>
<tr>
<th>1.) Diffuse</th>
<th>2.) Localized</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TREATMENT</strong></td>
<td>• Inside the tissues or body cavities</td>
</tr>
<tr>
<td>• Surgical exploration</td>
<td><strong>TREATMENT</strong></td>
</tr>
<tr>
<td>• Open therapy</td>
<td>• surgical exploration</td>
</tr>
<tr>
<td>• $\text{H}_2\text{O}_2$ and antibiotics</td>
<td>• drainage</td>
</tr>
<tr>
<td>e.g. anaerobic necrosis</td>
<td></td>
</tr>
</tbody>
</table>

---
Complications of wound healing

I. Early complications

Mixed wound infection

e.g. gangrene
  • necrotic tissues
  • putrid and anaerobic infection
  • a severe clinical picture

TREATMENT
  • aggressive surgical debridement
  • effective and specified (antibiotic) therapy
Complications of wound healing

II. Late complications

- Atrophic scar
- Hyperthrophic scar
- Keloid formation
- Necrosis
- Inflammatory infiltration
- Abscesses
- Foreign body containing abscesses
Atrophic scar

- Insufficient collagen production
- Injury of subdermal tissues: muscle, fat
- Staphylococcus infection
- Acne, pox

TREATMENT
excision
Late complications

Hypertrophic scar

- Develop in areas of thick chorium
- Non-hyalinic collagen fibres and fibroblasts
- Confine to the incision line

TREATMENT

- Regress spontaneously (1-2 yrs)
- W or Z plasty
Keloid

- Mostly African and Asian population
- Well-defined edge
- Emerging, tough structure
- Overproliferation of collagen fibers in the subcutaneous tissue
- Subjective complains

*TREATMENT*
- Postoperative radiation
- Corticosteroid + local anaesthetic injection
- Excision – 50-80% renew
### Comparison

<table>
<thead>
<tr>
<th></th>
<th>Hypertrophic scar</th>
<th>Keloid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>symptoms</strong></td>
<td>Linear, not extend over the wound edges</td>
<td>It extend over the wound edges</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rubber-like or tough</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Growing for years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Itches, pain, esthetic problem</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90% after burning</td>
<td></td>
<td>Afroamerican, south-american and asian population</td>
</tr>
<tr>
<td>anybody</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Predilection place</strong></td>
<td>Back, scull, palm, knee, elbow</td>
<td>Presternal region, shoulder, chin, ears, ankle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>factors</strong></td>
<td>Dermis injury, increased immun reaction</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ECM disfunction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collagen turnover</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dermis injury</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hormonal factors</td>
</tr>
<tr>
<td><strong>histology</strong></td>
<td>Elevated level of III type collagen, myofibroblasts, big</td>
<td>Elevated level of I and III type collagen fibers, thicker, desorized</td>
</tr>
<tr>
<td></td>
<td>extracellular collagen fibers, in dermis: aggregated</td>
<td>Few cells</td>
</tr>
<tr>
<td></td>
<td>fibroblast</td>
<td></td>
</tr>
</tbody>
</table>
BLEEDING AND HEMOSTASIS
# Bleeding

<table>
<thead>
<tr>
<th>Anatomical</th>
<th>Diffuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial – bright red, pulsate</td>
<td>Capillary – can become serious</td>
</tr>
<tr>
<td>Venous – dark red, continuous</td>
<td>Parenchymal</td>
</tr>
</tbody>
</table>
# Bleeding

Severity of bleeding – the volume of the lost blood and time

<table>
<thead>
<tr>
<th>Class of haemorrhagic shock</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood loss (mL)</td>
<td>Up to 750</td>
<td>750–1500</td>
<td>1500–2000</td>
<td>&gt; 2000</td>
</tr>
<tr>
<td>Blood loss (% blood volume)</td>
<td>Up to 15</td>
<td>15–30</td>
<td>30–40</td>
<td>&gt; 40</td>
</tr>
<tr>
<td>Pulse rate (per minute)</td>
<td>&lt; 100</td>
<td>100–120</td>
<td>120–140</td>
<td>&gt; 140</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>Normal</td>
<td>Normal</td>
<td>Decreased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Pulse pressure (mm Hg)</td>
<td>Normal or increased</td>
<td>Decreased</td>
<td>Decreased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Respiratory rate (per minute)</td>
<td>14–20</td>
<td>20–30</td>
<td>30–40</td>
<td>&gt; 35</td>
</tr>
<tr>
<td>Urine output (mL/hour)</td>
<td>&gt; 30</td>
<td>20–30</td>
<td>5–15</td>
<td>Negligible</td>
</tr>
<tr>
<td>Central nervous system/mental status</td>
<td>Slightly anxious</td>
<td>Mildly anxious</td>
<td>Anxious, confused</td>
<td>Confused, lethargic</td>
</tr>
</tbody>
</table>
The direction of hemorrhage

- **External**
- **Internal**
  - In a luminar organ (hematuria, hemoptoe, melena)
  - In body cavities (intracranial, hemothorax, hemascos, hemopericardium, hemarthros)
  - Among the tissues (hematoma, suffusion)
Signs of the bleeding

Local

- Hematoma, suffusion, ecchymosis
- Compression in the pleural cavity, in pericardium, in the skull
- Functional disturbances – e.g. hyperperistalsis

General

- Pale skin, cyanosis, decreased BP. and tachycardia, difficulty in breeding, sweeting, decreased body temperature, unconsciousness, cardiac and laboratory standstill, laboratory disorders, signs of shock

Initial hemostasis tests:
- CBC and platelet count
- PTT
- PT
- Fibrinogen or TT (optional)
If bleeding history is strong, consider performing initial VWD assays
Surgical hemostasis

Aim – to prevent the flow of blood from the incised or transected vessels

- Mechanical methods
- Thermal methods
- Chemical and biological methods
Surgical hemostasis
Mechanical methods

- Digital pressure – direct pressure, e.g. Pringle maneuver
- Tourniquet
- Ligation
- Suturing
- Preventive hemostasis
- Clips
- Bone wax
- other
Thermal methods

- **Low temperature**
  - Hypothermia – eg. stomach bleeding
  - Cryosurgery
    - dehydratation and denaturation of fatty tissue
    - decreases the cell metabolism
    - vasoconstriction
Thermal methods

- **High temperature**
  - Electrosurgery – electrocauterization
  - Monopolar diathermy
  - Bipolar diathermy

  - Laser surgery
    coagulation and vaporization
    for fine tissues
Thermal methods

- High temperature
  - Electrocoagulation
  - Electrofulguration
  - Electrodessication
  - Electrosection
<table>
<thead>
<tr>
<th>Hemostasis with chemical and biological methods</th>
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<tr>
<td>vasoconstriction</td>
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<td>Absorbable collagen</td>
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<td>Microfibrillar collagen</td>
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<td>Oxytocin</td>
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<td>Hemcon</td>
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