Postmortem Changes

Done by:
Boshra Al-Rbaihat
Omar Kutkut

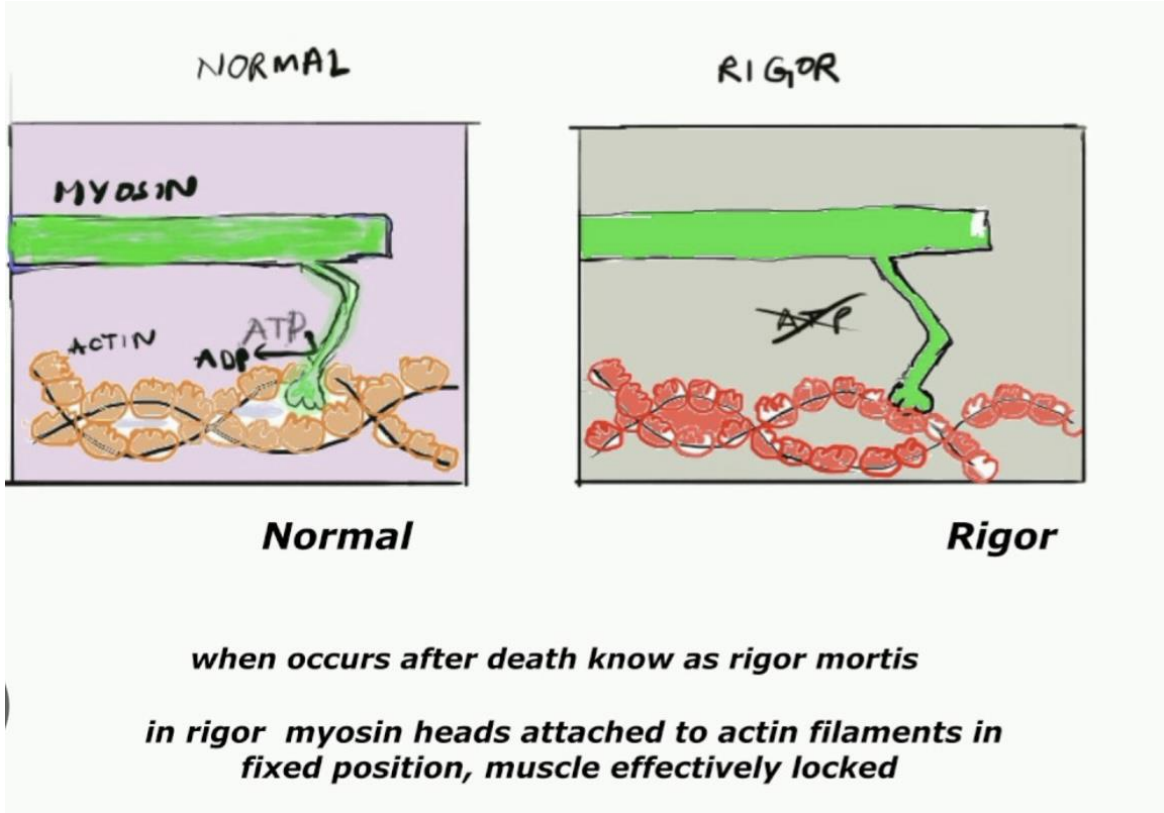
Rigor Mortis

- is that state of the muscles in a dead body when they become stiff or rigid with some degree of shortening.
- The phase of primary relaxation of the muscles continues for about an hour which is followed by stiffening or rigidity. It indicates molecular death of the concerned muscles

Rigor mortis

Rigor mortis is the postmortem stiffening of muscles caused by the depletion of adenosine triphosphate (ATP). Without ATP to break the actin-myosin cross-bridges, muscles remain locked in a contracted state.

Onset and duration: typically appearing 1–2 hours after death, peaking at 12 hours, takes about 9-12 h to develop from head to foot, persists for another 12 h and takes 12 h to pass off



- Develops faster in case of electrocution, running (faster ATP depletion), high temperature.

- Start in the all muscles at the **same time,** but first seen in the **small** muscles, primarily the eyelid(orbicularis oculi), jaw & neck ,**the cause is the number of the muscle fiber.**

- Among voluntary muscles develops sequentially & descending pattern.

- The rigidity disappears in the same order in which it has appeared and ends due to the muscle fibers autolysis (secondary flaccidity).

Effects of rigor mortis

- Goose skin appearance (cutis anserina) due to rigor of erector pili muscles
- Postmortem ejaculation from contraction of seminal vesicle Muscles
- Contraction of heart muscle may mimic myocardial hypertrophy
- Rigor mortis of uterus cannot expel the fetus
- iris is affected → pupil size becomes unreliable for diagnosing antemortem toxic or neurological conditions

Factors affecting rigor mortis:

- **Temperature:** Heat accelerates the chemical reactions of rigor mortis (faster onset, faster passing), while cold temperatures delay it.
- **Physical activity before death:** Strenuous activity or convulsions deplete ATP (adenosine triphosphate) rapidly, leading to a faster onset.
- **Muscle mass and condition:** more muscle mass will generally display more pronounced stiffness, while cachexia (severe muscle wasting) or thin individuals will exhibit it less.
- **Cause of death:** Death resulting from high fever, asphyxia, or electrocution can accelerate the process, whereas death from debilitating, long-term diseases may delay it.
- **Environmental conditions:** Humidity and air movement also influence the speed of postmortem changes.

Medico-legal Importance of Rigor Mortis

-It is a sign of death and indicates **molecular death** of the involved muscles

-Helps in estimating **time** since death (early postmortem period):

- In summer, absence of rigor mortis → death within ~2 hours
- If rigor mortis involves the whole body → death occurred ~12–24 hours earlier

-Indicates the **position** of the body at the time of death (fixes posture)
Example: raised lower limbs suggest the body became rigid in a different position and was moved later.

-**Conditions** that may simulate rigor mortis:

1. Heat stiffening
2. Cold stiffening
3. Gas stiffening (putrefaction)
4. Cadaveric spasm (instantaneous rigor)

Cadaveric Spasm

-is a condition in which the muscles of the body which were in a state of contraction immediately before death, continue to be so after death **without** passing through the stage of **primary relaxation.**

-It is a rare phenomenon of instantaneous rigor, which develops at the time of death with no period of postmortem flaccidity.

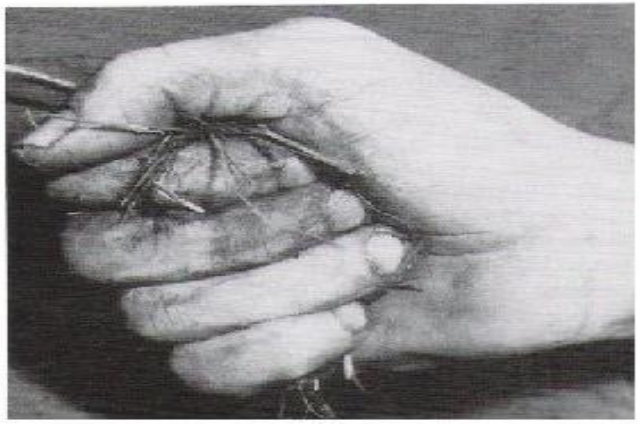
Predisposing conditions:

It occurs especially in cases of sudden death, excitement, fear, severe pain, exhaustion, cerebral hemorrhage, electrocution, injury to the nervous system, firearm wound of the head, or convulsant poisons.

Muscles involved:

The spasm is primarily a vital phenomenon; it originates by normal nervous stimulation of the muscles.

it is usually limited to a single group of voluntary muscles, and frequently involve the hands



Cadaveric spasm in a drowning victim: had grass from the river bank firmly clutched in the hand

Medico-legal Importance Cadaveric spasm

- A rare **antemortem phenomenon** associated with events just before death
- Occurs **immediately at the time of death** (no primary relaxation phase)
- Involves **voluntary muscles**, most commonly the **hands**
- Preserves the **last act performed** by the deceased
- Usually linked to **intense emotion, stress, or physical activity**

Forensic Importance:

- Helps in determining the **cause of death**
- Helps in assessing the **manner of death** (suicide, homicide, accident)

Examples:

1.Drowning:

Hand tightly grips **sand, mud, gravel, or weeds** from the water source

2.Suicide (firearm or stab injury):

Weapon (pistol/knife) found **firmly grasped** in the hand

Suggests **self-inflicted injury** (strong presumptive evidence)

3.Homicide:

Victim may grasp **attacker's hair, clothing, or objects**

Indicates **struggle before death**

Cadaveric Spasm vs Rigor Mortis

Feature	Cadaveric Spasm	Rigor Mortis
Onset	Immediate (at moment of death)	Gradual (starts after 1–2 hours)
Muscles involved	Voluntary muscles only (commonly hands)	All muscles (voluntary + involuntary)
Sequence	No definite sequence (localized)	Definite sequence (head → toe)
Cause	Intense emotion, stress, or activity before death	Biochemical changes (ATP depletion) after death
Primary relaxation	Absent	Present before onset
Occurrence	Rare	Common (occurs in all deaths)
Forensic value	Indicates last act before death	Helps estimate time since death
Example	Object/weapon tightly grasped in hand	Generalized body stiffness

Heat Stiffening

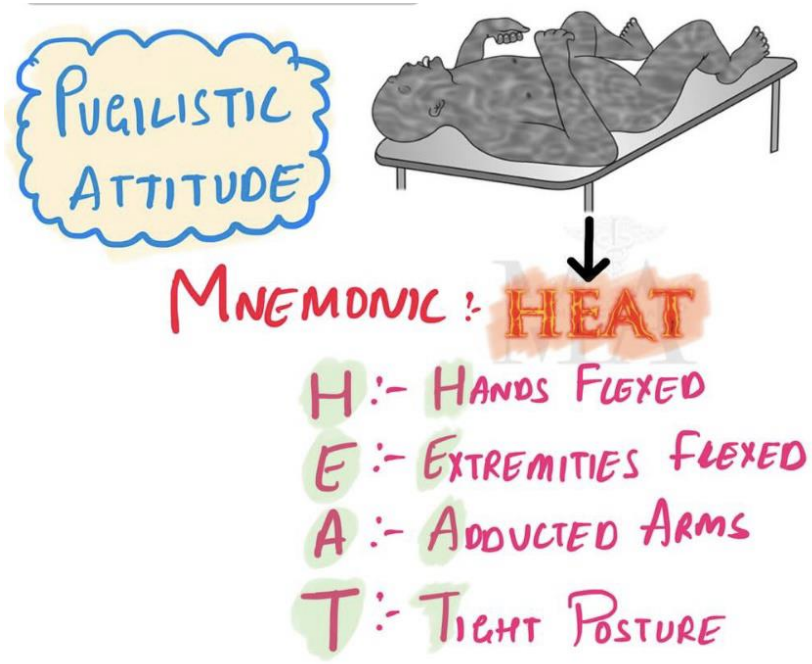
- If the body is subjected to heat exposure at > 65˚C, rigidity is produced which is much more marked than that found in rigor mortis.

-There will be coagulation of the muscle protein in which the flexors are affected more, giving rise to a pugilistic attitude of the body

-The muscles are contracted, desiccated or even carbonized on the surface

-A zone of brownish-pink ‘cooked meat' is seen under this, overlying normal red muscle.

Posture: The limbs often show flexion, particularly in the arms and legs, because flexor muscles are stronger than extensor muscles, resulting in a defensive "boxer-like" posture. **(pugilistic attitude)**



Cold Stiffening

This is seen when a body is exposed to freezing temperatures for a reasonable period, the tissues becoming frozen and stiff, simulating rigor.

It occurs due to:

1. Freezing of body fluids, particularly at the tissue level and in the synovial sacs of the joints
2. Hardening of the subcutaneous fatty tissue

Secondary Relaxation of Muscles

- After some hours of stay, rigor mortis passes away and the body becomes relaxed or flaccid for the second time. This is secondary relaxation or secondary flaccidity of the muscles. It occurs with the onset of decomposition or putrefaction of the dead body

Decomposition/Putrefaction

- is a process by which complex organic body tissue breaks down into simpler inorganic compounds or elements, due to:

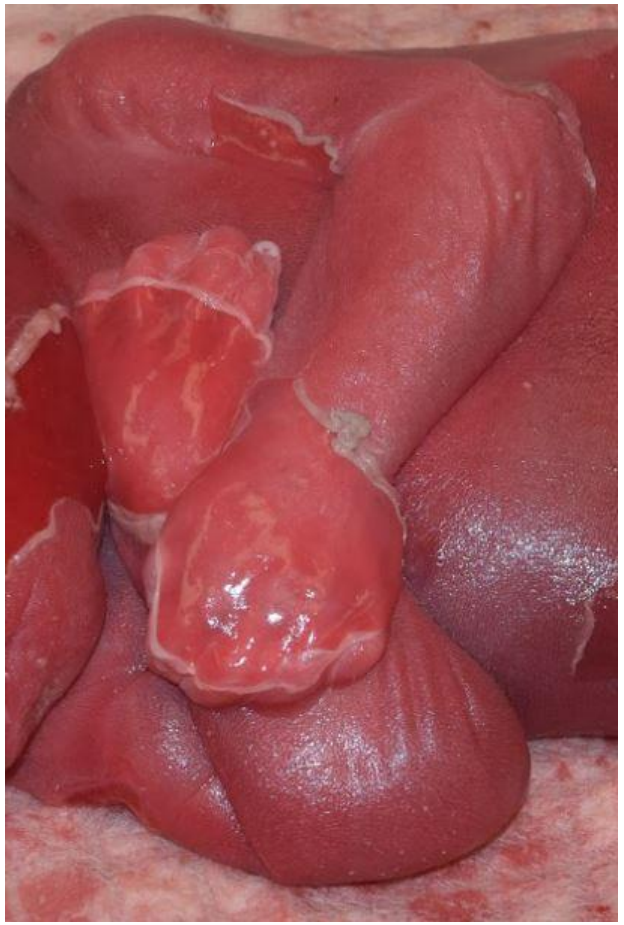
1. The action of saprophytic microorganisms
2. Autolysis

-Putrefaction usually follows the disappearance of rigor mortis.

- After death, the body's protective functions are absent and its defense barrier is lost, Saprophytic microorganisms, physical and chemical agents, all act on the dead body.

- Without physiological control after death, enzymes that normally support metabolic processes begin to act adversely by breaking down the body's own tissues (autolysis).

- Main organism in putrefaction: Clostridium welchii (C.Perfringens).



- Maceration: is the process of aseptic autolysis of dead fetus in utero surrounded with amniotic fluid.

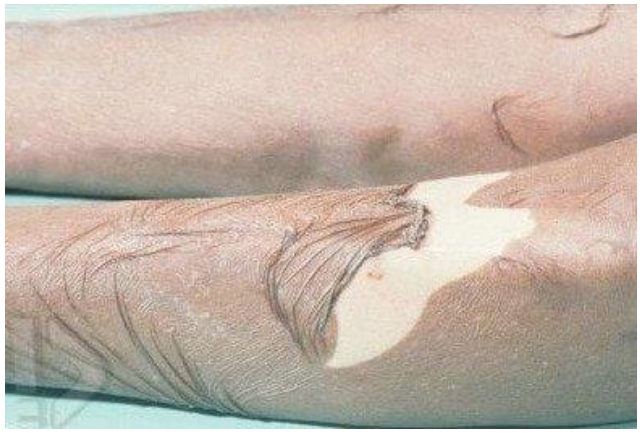
Factors affecting putrefaction

- Temperature and moisture: elevated temperature & prescence of moisture, **faster** putrefaction.
- Condition of the body: well-nourished bulky fatty body promotes micro-organisms growth (**faster**).
- Cause of death: septicemia leads to **faster** putrefaction.
- Multiple antibiotics prior to death leads to **slower** putrefaction.
- External injury: Open wound leads to **faster** putrefaction.

External Signs of Decomposition

- **Decomposition changes (‘4 Ds')**

1. Discoloration: Greenish discoloration in the lower abdominal quadrants. Due to hydrogen sulfide (H2S).



2. Distension: Various gases produced during decomposition permeate into skin, soft tissue and organs which manifests as crepitus and distension.

3. Degradation: loss of anatomic integrity of skin and other tissues such as localized peeling of skin (‘skin slippage'), loosening of skin of hands and feet (‘degloving') and loosening of hair and nails.

4. Dissolution: Progressive decomposition leads to liquefaction and disappearance of tissues and organs, and eventual skeletonization

Discoloration

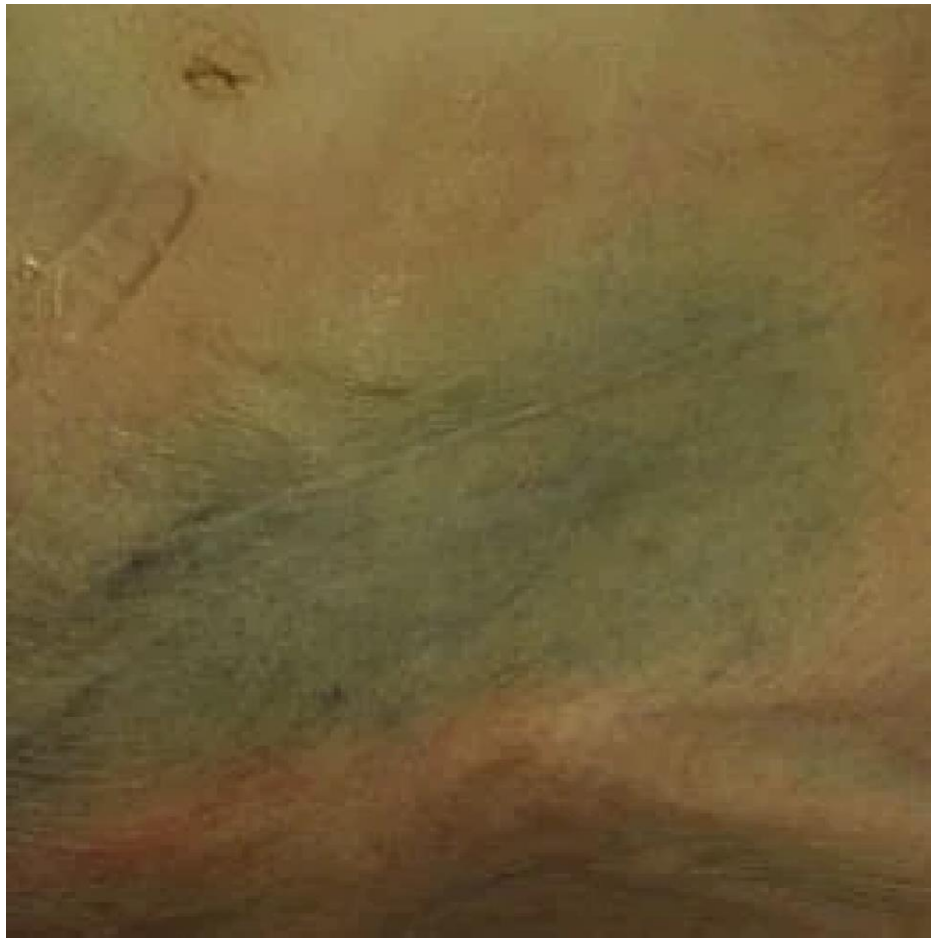
–The first external sign of decomposition.

–Greenish discoloration over the right iliac fossa (region of the cecum)due to the reaction between H2S and Hb leading to SulfHb.

–C.welchii are most abundant at the iliocecal zone.

–Internally, this is seen on the undersurface of the liver, where it is in contact with the transverse colon.

–Decomposition starts immediately after death but appears as discoloration in 36-48 hours.



Marbling' of skin

- The blood vessels provide an important route through which the bacteria can spread with ease throughout the body.

- Their passage is marked by the decomposition of hemoglobin to sulphmethemoglobin in the blood vessels, which causes a greenish or reddish-brown staining of the inner walls of the superficial vessels.

- This is seen as linear branching patterns, which gives a 'marbled' ('road map') appearance of the skin.

- Areas where visible: It appears first in the shoulder, roots of the limbs, thighs, sides of abdomen, chest and neck.

Internal Changes due to Putrefaction

–The organs composed of muscular tissue and those containing large amount of fibrous tissue resist putrefaction longer than the parenchymatous organs, with the exception of the stomach and intestine, which decompose rapidly because of their contents at the time of death.

–**Prostate and uterus** (dense, fibrous muscular tissue) being the **last organs** to decompose, they help to identify the sex of the dead bodies in advanced state of decomposition

Adipocere (Saponification)

- is formation of an offensive, sweet rancid smelling, soft, whitish or grayish white, crumbly, waxy and greasy material (similar to soap) occurring in fatty tissues of a dead body. It is a **modification of decomposition.**

- In **hot and moist** environment, it may occur by the end of 1 week In temperate countries, it starts in 3 weeks and completes in about 3 months.

Mechanism of formation:

Adipocere consists mainly of fatty acids formed due to postmortem hydrolysis and hydrogenation of body fats. The process needs water which is provided by the body fluid of soft tissues. The chemical reaction essentially involves conversion of unsaturated liquid fats (oleic acid) to saturated solid higher fatty acids, like palmitic.

-A **warm**, **moist** and anaerobic environment favors adipocere formation.

Medico-legal Importance of adipocere

i. **Sign of death:** It is the **surest sign** of death.

ii. **Time since death:** It gives a rough estimate about the time since death.

iii. **Personal identification:** When the process involves the face, the features are **well-preserved**, which helps in identification.

iv. **Recognition of injuries:** The cause of death may be determined, since injuries can be recognized.

v. **Place of disposable of body:** Some idea about the place of disposal of the body can be made**, since its formation requires a warm place with high humidity or presence of moisture or water.**

Mummification

-It is the rapid dehydration/desiccation and shriveling of the dead body from evaporation of water, with preservation of natural appearances and features of the body.

- It is a **modification of putrefaction** (**dry** decomposition)

-The entire body loses weight, becomes thin, stiff, brittle and odorless

-Time required for mummification: It varies between 3-12 months or longer

Factors Favoring Mummification

i. **Hot** environment: As in the deserts.

ii. **Dry** atmosphere: Mummification cannot occur in humid conditions.

iii. Free air movement: It helps in rapid evaporation of body fluids.

iv. Contact of the body with absorbing media: A dead body lying in shallow grave, in dry sandy soils mummifies early due to absorption of body fluid rapidly.

v. Poisoning: Chronic arsenic or antimony poisoning favors the process of Mummification.

Skeletonization

-The final stage of decomposition characterized by the complete loss of soft tissue, leaving only the osseous framework.

-Casper’s Dictum : The rate of decomposition is highly environment-dependent; decomposition typically progresses eight times slower in a buried environment than in open air (1:2:8 ratio for air, water, and earth).