

Changes in Muscles

After death all muscle of the body(Voluntary, involuntary and cardiac) passes through 3 phases i) Primary relaxation ii) Rigor mortis iii) Secondary relaxation.

Primary relaxation or flaccidity- is complete relaxation of muscle in the period immediately after somatic death. **Features**1) **Relaxation of skeletal muscle causes** i) Contact flattening-flattening of muscles which are in contact with surface e.g gluteal and scapular muscle when the body in supine position. ii) Eye lids-Loose tension. Lower jaw falls . Joint becomes flexible. **Relaxation of involuntary muscles causes** i) Pyloric sphincter- duodenal content moves up ii) Anal sphincter-emptying of rectum iii) Bladder sphincter-emptying of bladder. **Persists** throughout supravital period. Muscle protoplasm is slightly alkaline.

Rigor Mortis(Latin rigor-stiffness,mortis-death)is a state of stiffening of muscle with very little shortening of fibers that occurs soon after death. **Mechanism**-A sarcomere is basic unit of muscle inturn composed of Actin(Thin filament) Myosin(Thick filament). **During life in relaxed state**-Myosin remains in adsorbed state due to presence of ATP molecules on its surface which keep muscle in hydrated state. Actin filament interdigitate with myosin filament to small extent. **During life in contracted state**- Under the influence of nerve impulse actin filament drawn into the myosin causes muscle to contract. There is appreciable shortening of sarcomere. The ATP molecule on the surface of myosin prevents permanent cross linkage between them.

After death- Two conditions may prevail i) **When muscle was robust with abundant glycogen and ATP-** Anaerobic glycolysis continues to occur producing more ATP in turn formation of more lactic acid and pyruvic acid. Lactic acid content of resting muscle during life is .03% during RM .3%. Muscle PH decreases, when PH reaches 5.8 glycolysis stops, by this time very little glycogen remain in muscle and ATP starts depleting. When they are completely consumed, permanent

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- Irreversible cross linkage form between actin and myosin. Since PH of muscle is acidic and the rigor produced under initial condition of abundant glycogen and ATP is K/as acid rigor. ii) **Muscle was with minimal glycogen store**- Lactic and pyruvic acid not formed, rigor develops but muscle remains alkaline(alkaline rigor).
- **Order of appearance of Rigor**- It appears in all muscles in order- Cardiac muscle(1 hr)- involuntary muscle- voluntary muscle. **R M in involuntary muscle**- i)arrector pilorum causes gooseflesh ii) may produce anisocoria(unequal size of pupils. iii) emission of semen due to contraction seminal vesicle.
- **Nysten's Law**- is applicable to voluntary muscle and states that muscle which are nearest to brain go into rigor first and those farthest go into rigor last, thus rigor appears in this order eyelid(2hr)-jaw (3hrs)- upper limbs(6hrs)-lower limb(9hrs)- fingers and toe(12hrs) after French pathologist Pierre Hubert Nysten also K/as proximo-distal progression.
- **R M is a physicochemical process.**
- **Duration of R M**- Rigor mortis appears in the entire body in 12 hrs persists for another 12 hrs then disappears in next 12 hrs in the same order in which they appeared but this is not always followed by all the dead bodies and no. of factors(internal and external) affects the process of R M.
- **Demonstration-A. Skeletal muscles**-i) try to open eyelid ii) try to open or close mouth easily. lii) upper limb- trying to flex or extend at shoulder, elbow, wrist and fingers. Same at hip joint, knee joint, ankle joint and toes.
- **B. Cardiac muscle**- appears tough and more solid in R M.
- **C. Smooth muscle**- no convincing way to demonstrate R M in smooth muscle.

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- **Factors affecting onset and duration of R M**
- **Age**-R M appears in all ages, even in foetuses. R M develops in all where muscle have been formed.
- **Physique of the subject**- R M comes early and passes of early in thin built subject and reverse happens in well built subject.
- **Atmospheric temperature**- At high temperature R M comes early and passes of early and reverse in cold atmosphere.
- In death due to exhaustive disease or convulsion precedes death R M appears and passes of early. R M sometimes absent in septicemia.
- **Medicolegal Importance of R M**- i) It is a sign of death ii) Helps in estimation of Time since death to some extent. iii) It indicate position of body at the time of death.
- **Condition simulating R M**- i) **Cadaveric spasm- (cataleptic rigidity, instantaneous rigidity or rigor, postmortem spasm)** is a rare condition in which muscle that were in contraction at the moment of death remain in contraction after death without passing through the stage of primary relaxation. Thus it is not just stiffening of muscle but muscles are in contracted state in cadaveric spasm. The spasm involves one or group of muscles of the body. **Predisposing conditions**-excitement, fear, fatigue, exhaustion, severe pain and sudden death. **Medicolegal Importance**- It is an antemortem phenomenon in origin, which continues after death reflects last act done by person at the time of death. Thus from Cadaveric spasm sometimes cause of death and some times manner of death can be guessed. In case of dead body, if the hand is found flexed in state of cadaveric spasm and grip contains mud, sand, weeds then it indicates that at time of death subject was alive and must have died due to drowning. In a case of death due to cut throat, due to cut at wrist (radial artery) if the weapon used say sharp cutting weapon is found in tight grip (cadaveric Spasm) of hand and the position of weapon in hand matching with injury found over neck and wrist, the person in most probability committed suicide.

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ii) **Heat stiffening**-If death occurs due to superficial burn injuries(2nd and 3rd degree) or if the subject is exposed to more than 65 degree Celsius then there will be coagulation of muscle protein and body will be stiff with contraction of muscle(flexion) at all joints giving rise to condition K/as **Pugilistic or boxer's or fencing attitude** of body.

iii) **Cold stiffening**- This occurs when body remain in extremes of cold for a reasonable period. Here stiffening occurs due to i)freezing of body fluid. li) due to hardening of subcutaneous fat. If the stiffening is due to cold then the body temp. will be below 0 degree Celsius, there will be cracking sound if the joints are manipulated and the body will be flaccid if kept at ordinary temp. for some period after which rigor mortis appears.

iv) **Gas stiffening**- occurs during the stage of decomposition where the cause of stiffening is due to accumulation of gases produced in process of decomposition and can easily be differentiated by discoloration, swelling and foul smelling gases coming out from body. **Difference between RM and Heat stiffening-**

| Features | Rigor Mortis | Heat stiffening |
|------------------------|--------------------------------------|---|
| Degree of stiffness | Moderate | High |
| Time of formation | 1 or 2 hrs to 12 hrs after death | Due to exposure to heat |
| Role of heat | Atm. high temp. enhances the process | Occurs at temp above 65 degree C |
| Mechanism of formation | Due to break down of muscle ATP | Coagulation of protein due to heat |
| External appearance | Nothing specific | Burning, blackening and blister formation |

Difference between R M and cadaveric spasm-

| Features | Rigor Mortis | Cadaveric Spasm |
|------------------------|---------------------------------------|--|
| Onset | Within 1 or 2 hrs after death | Instantaneous with death |
| Muscle involved | All the muscle of body gradually | Skeletal muscle which are in contracted state at time of death |
| Primary flaccidity | Precedes Rigor Mortis | Without primary flaccidity |
| Intensity of rigidity | Comparatively moderate | Comparatively stronger |
| Death of muscle | Molecular death occurs | No molecular death of muscle |
| Duration of stay | About 12-18 hrs | Few hrs until replaced by R M |
| Predisposing factor | Nil | Excitement, fear, fatigue, exhaustion |
| Body temp. | Low | Warm |
| Muscle reaction | Acidic | Alkaline |
| Reaction to stimulus | Does not respond | Responds |
| Mechanism of Formation | Breakdown of ATP below critical level | Not known exactly |
| Medicolegal Imp | Helps in estimation of TSD | Cause and manner of death |

Some features observed during stay of R M-1. Due to rigidity in heart muscle during R M emptying of chambers. 2. Pupils are constricted due to R M in iris muscle. 3. R M in uterine muscle can not expel foetus from gravid uterus. 4. R M appears in paralyzed and amputated limb.

Difference Between Primary and Secondary relaxation of muscles

| Feature | Primary relaxation | 2ndry relaxation |
|------------------------|---------------------------|---|
| Time of occurrence | Immediately after death | After R M passes off |
| Death of muscle tissue | Has not occurred | Molecular death of muscle has occurred |
| Response to stimuli | Responds | Does not respond |
| Other external | Nothing special | Signs of decomposition |
| Body Temperature | Nearer to normal | Low or high nearer to atmospheric temperature |