

# Circulatory Reactions

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**This presentation includes only the most important terms and facts. Its content by itself is not a sufficient source of information required to pass the Physiology exam.**

# Circulatory Reactions

- Regulation of circulation – a complex system of feedbacks, dynamic balance.
- Individual parameters regulated by neural and humoral mechanisms, both systemic and local – their quantitative ratio changes dynamically.
- Physiological stimuli in a healthy person - rather standard reaction.

# Circulatory Reactions

- **Orthostatic / Clinostatic Reaction**

- a change of the body position from lying to standing / from standing to lying

- due to **gravity**:

→ ↑ BP in all vessels below the heart level

→ ↓ BP in all vessels above the heart level

sudden closure of venous valves due to ↑ BP + ↑ venous pressure due to continuous blood inflow from arteries → **total filling of veins considerably ↑, blood flow sustained → dilation of veins**

↓ venous return → ↓ stroke volume → ↓ **BP** (also due to the direct effect of gravity) → **inhibition of baroreceptors (baroreflex)**

*orthostatic hypotension*

# Circulatory Reactions

- **Orthostatic / Clinostatic Reaction**

- a change of the body position from lying to standing / from standing to lying

- orthostatic reaction – due to **gravity**:

- a) acute reaction – passes within 1 min  
(*tilt-up test*)

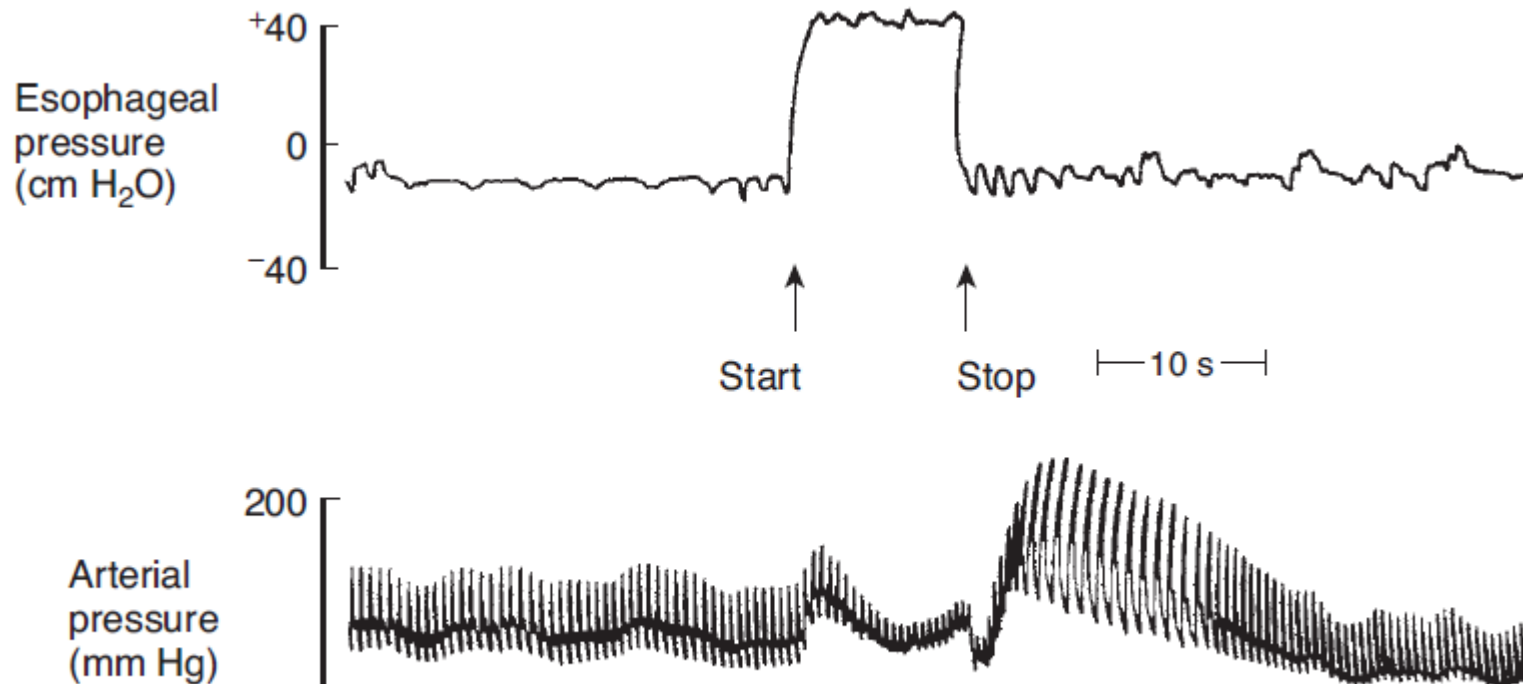
- b) subsequently:

↑ **capillary filtration** → ↓ plasma volume

↑ level of ADH + ↑ activity of RAS + reflex vasoconstriction in kidneys → ↓ **excretion of salt and water in kidneys**

# Circulatory Reactions

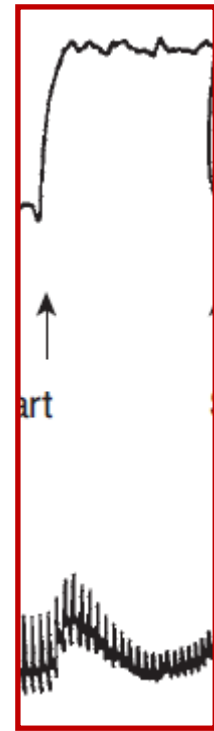
- **Valsalva Maneuver**
- forced expiration over closed or narrowed glottis (cough, defecation, lifting of heavy objects, *etc.*)



Ganong's Review of Medical Physiology, 23<sup>rd</sup> edition.

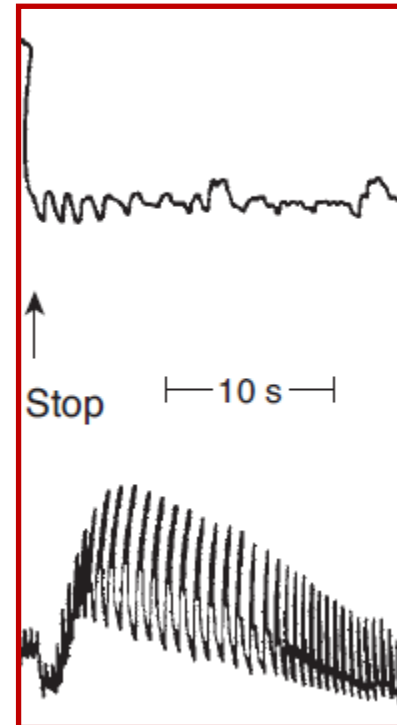
# Circulatory Reactions

- **Valsalva Maneuver**
- **start of maneuver** → ↑ **intrathoracic pressure**:
  - ↑ **BP**
  - compression of chest vessels → ↓ **venous return** → ↓ stroke volume (Frank-Starling) → ↓ pulse and mean **BP** → **inhibition of baroreceptors** → **reflex tachycardia and vasoconstriction** → mean BP at the level before maneuver



# Circulatory Reactions

- **Valsalva Maneuver**
- **end of maneuver → ↓ intrathoracic pressure:**  
→ opposite changes





# Circulatory Reactions

- **Respiratory Sinus Arrhythmia**
- rhythmic changes of heart rate related to breathing
- several mechanisms discussed, namely:
  - mechanoreceptors in lungs
  - Bainbridge reflex
  - baroreflex

# Circulatory Reactions

- **Respiratory Sinus Arrhythmia**

- rhythmic changes of heart rate related to breathing

- inspiration → ↑ HR, expiration → ↓ HR

- inspiration → ↑ lung volume (stretch rec.) → ↑ HR  
→ ↓ intrathoracic pressure:

↓  
↑ venous return

←  
**Bainbridge reflex**  
(distension of atria)

→ ↑ HR

→ ↑ stroke volume → ↑ BP →  
**stimulation of baroreceptors**

→ ↓ HR

(during expiration)

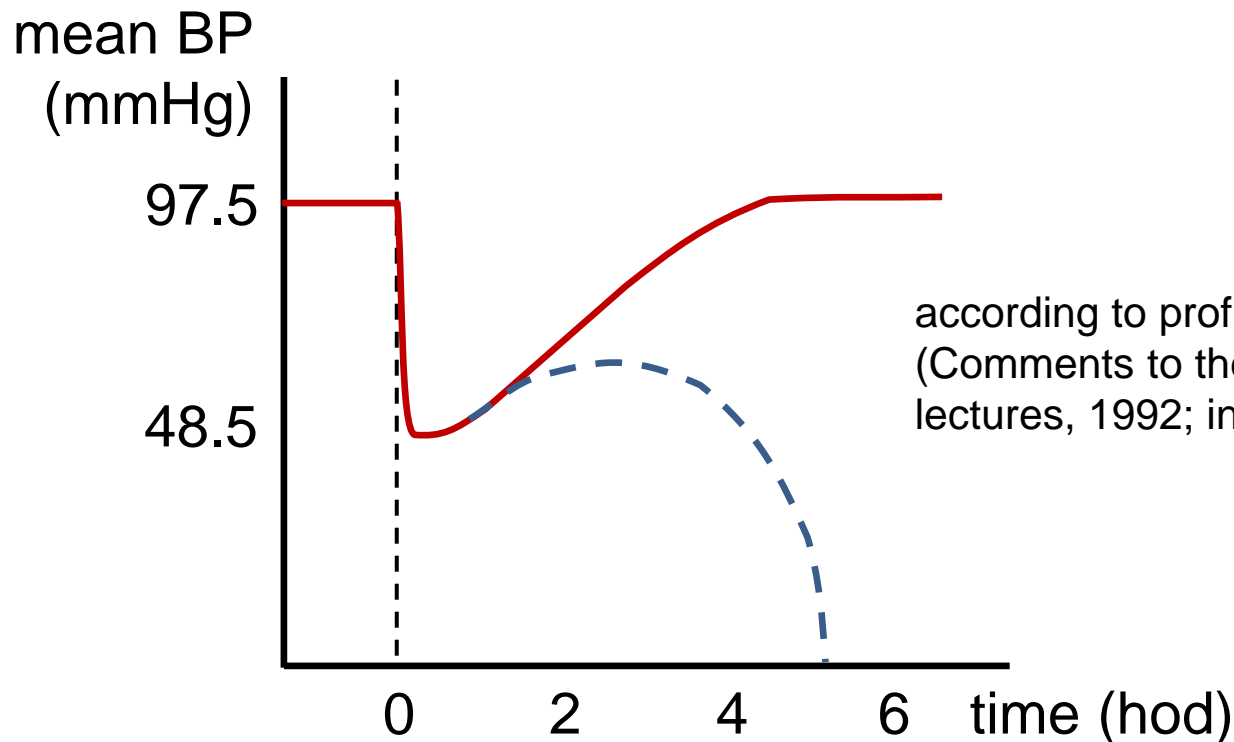
# Circulatory Reactions

- **Diving Reflex**
- diving – excitation of receptors of *n. trigeminus* by cold water:
  - apnoe
  - bradycardia
  - peripheral vasoconstriction
- ~ conservation of limited O<sub>2</sub> reserves for function of brain and heart → prolongation of diving period

# Circulatory Reactions

- **Reaction on loss of blood**

- bleeding  $\rightarrow$  hypovolemia  $\rightarrow$   $\downarrow$  venous return  $\rightarrow$   $\downarrow$  SV  $\rightarrow$   $\downarrow$  CO  $\rightarrow$   $\downarrow$  BP (even shock)



according to prof. N. Honzíková  
(Comments to the physiological  
lectures, 1992; in Czech)

# Circulatory Reactions

- **Reaction on loss of blood – sudden**
- The resulting state is dependent on the amount of lost blood and on the velocity of loss of blood!
- **loss of 10 % of the blood volume (~ in a blood donor):**
  - → slightly and transiently ↓ BP
- **loss of 20-30 % of the blood volume :**
  - → ↓ mean BP to about 60-80 mmHg
- **loss of 30-40 % of the blood volume :**
  - → ↓ mean BP to about 50-67.5 mmHg → shock, may shift into an irreversible state

# Circulatory Reactions

- **Reaction on loss of blood – sudden**
- bleeding → hypovolemia → ↓ venous return → ↓ SV  
→ ↓ CO → ↓ BP (even shock)
- Instantaneous reaction (seconds till minutes)
- Reaction within 5 - 60 min
- Reaction within hours till days

# Circulatory Reactions

- **Reaction on loss of blood – sudden**
- **Instantaneous reaction on ↓ BP (seconds till minutes)**
- ↓ stimulation of **baroreceptors**
- **limited tissue perfusion** due to ↑ PR → metabolic acidosis
- **limited renal perfusion** due to ↑ PR (*v. eff. > v. aff.*) → ↑ FF  
but, anyway, ↓ urine formation → retention of Na<sup>+</sup> in body  
(prospectively also of waste nitrogen products – uremia!)
- **RAS activation (angiotensine II, aldosteron) + ↑ secretion of ADH, thirst**

# Circulatory Reactions

- **Reaction on loss of blood – sudden**
- **Reaction on ↓ BP within 5 - 60 min**
- ↓ capillary hydrostatic pressure → **oncotic pressure > hydrostatic pressure** → reabsorption of fluids from the interstitial tissue into capillaries → **↑ volume of intravasal fluid** („internal transfusion“); consequences!
- The so far described reactions provide the sufficient blood flow through brain and myocardium.



# Circulatory Reactions

- **Reaction on loss of blood – sudden**
- **Reaction on ↓ BP within hours till days (even weeks)**
- **restoration of content of salt and water in the organism**
- **restoration of plasmatic proteins including albumin**
- **stimulation of erythropoiesis in the bone marrow**

# Circulatory Reactions

- **Reaction on loss of blood – sudden**
- irreversible state (shock) may be caused by:
  - primary heart failure
  - serious tissue hypoxia
- in both cases - *circulus vitiosus!*