

Circulatory Reactions

Assoc. Prof. MUDr. Markéta Bébarová, Ph.D.

Department of Physiology, Faculty of Medicine, Masaryk University



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)

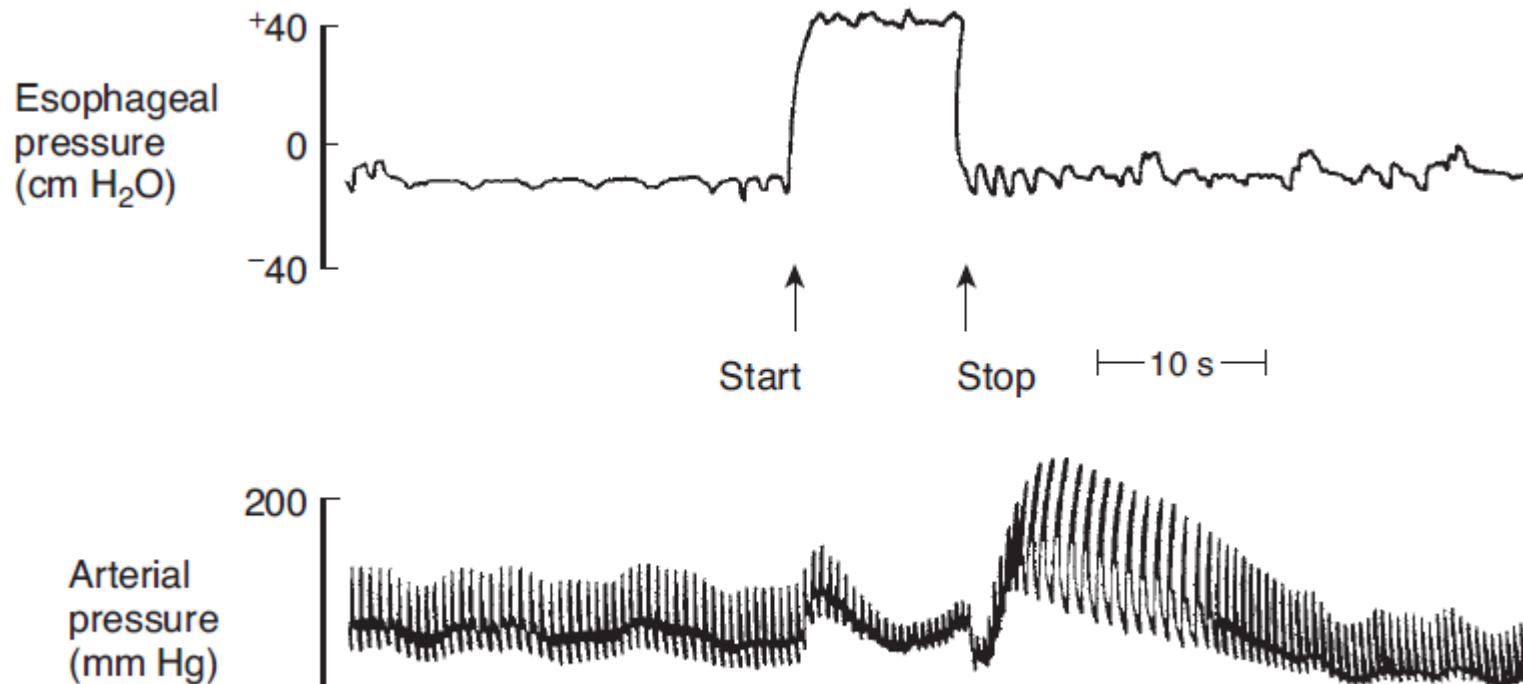
- b) subsequently:

↑ **capillary filtration** → ↓ plasma volume

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

Circulatory Reactions

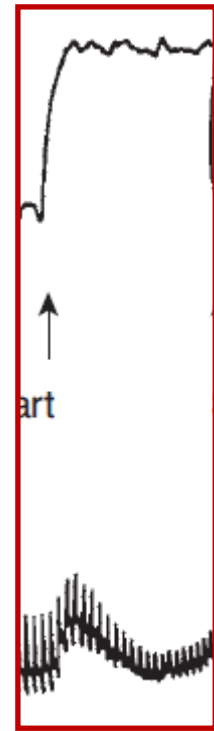
- **Valsalva Maneuver**
- forced expiration over closed or narrowed glottis (cough, defecation, lifting of heavy objects, *etc.*)



Ganong's Review of Medical Physiology, 23rd edition.

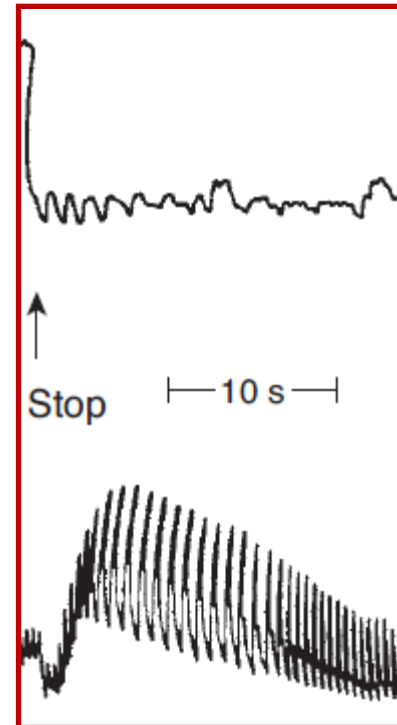
Circulatory Reactions

- **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

- **Diving Reflex**

- diving – excitation of receptors of *n. trigeminus* by cold water:

- apnoe

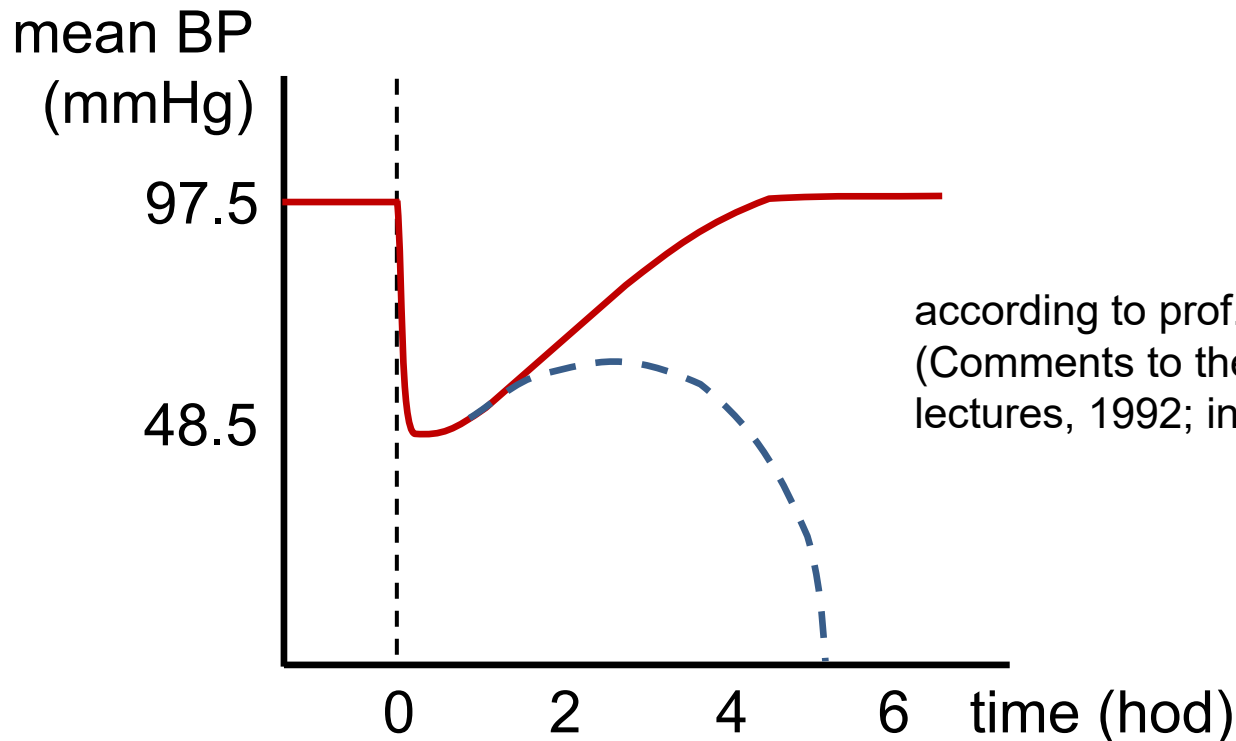
- bradycardia

- peripheral vasoconstriction

~ conservation of limited O₂ reserves for function of brain and heart → prolongation of diving period

Circulatory Reactions

- **Reaction on loss of blood**
- bleeding → hypovolemia → ↓ venous return → ↓ SV → ↓ CO → ↓ **BP** (even shock)



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⁺ 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 intravascular 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!*