Regulation

in cardiovascular system

Types of regulation - general view

2 basic types:

- ✓ Nervous regulation
- ✓ Humoral regulation
  - ✓ Feedback control - negative
  - ✓ - positive

autoregulation – local regulation – system regulation

REGULATION IN CARDIOVASCULAR SYSTEM

Main function:

- keep relatively constantaneous arterial blood pressure
- Keep perfusion of tissues

Regulation of vessels tone

- Tone of the vessels = basic tension of the smooth muscle inside of the wall

  (vasoconstriction x vasodilatation)

- Regulation - local autoregulation

  - system regulation

Autoregulation

Autoregulation – the capacity of tissues to regulate their own blood flow

Myogenic theory – Bayliss phenomenon (as the pressure rises, the blood vessels are distended and the vascular smooth muscle fibres that surround the vessels contract; the wall tension is proportional to the distending pressure times the radius of the vessels – law of Laplace)

Autoregulation

- **Metabolic theory** – vasodilator substances tend to accumulate in active tissue, and these metabolites also contribute to autoregulation
  - ending products of energetic metabolism – CO_2, lactate acid, K^+
  - effect of hypoxia (circulation: vasodilatation x pulmonary circulation: vasoconstriction)
  - Adenosin – coronary circulation: vasodilatation

Autoregulation

- **by substances which releasing from:**
  - endothelium
  - tissues

Substances secreted by the ENDOTHELIUM

Vasodilatation:

Nitric oxide (NO) from endothelial cells
(originally called: EDRF)
Prostacyclin is produced by endothelial cells

Thromboxane A2 promotes platelet aggregation
(important prostacyclin – thromboxan balance)

Vazoconstriction:

Endothelins (polypeptids – 21peptides)
three isopeptides: ET 1, ET 2 , ET 3

Substances secreted by the tissues:

Histamine – primarily tissue hormones.

General affect: vasodilatation - decrease periphery resistence, blood pressure

KININS: 2 related vasodilated peptides

Bradykinin + lysylbradykinin (kallidin).

Sweat glands, salivary glands

10x strongers than histamine

Relaxation of smooth muscle, decrease blood pressure

Systemic regulation

By hormones

Catecholamines – epinephrine, norepinephrine
- effect as activation of sympathetic system

RAAS - stress situation

ADH - general vasoconstriction

Natriuretic hormones - vasodilatation

Neural regulatory mechanism

Autonomic nervous system

Sympathetic: vasoconstriction

All blood vessels except capillaries and venules contain smooth muscle and receive motor nerve fibers from sympathetic division of ANS (noradrenergic fibers)

- Regulation of tissue blood flow
- Regulation of blood pressure

Parasympathetic part: vasodilatation

Only sacral parasympathetic cholinergic fibres (Ach) inervated arteriols from external sex organs

INTEGRATION of regulation in cardiovascular system

The regulation of the heart:

– Rami cardiaci n. vagi

Cardiac decelerator center - medula oblongata (ncl.dorsalis, ncl. ambiguus) – parasympathetic fibres of nervus vagus

: vagal tone (tonic vagal discharge)

Negative chronotropic effect (on heart rate)

Negative inotropic effect (on contractility)

Negative dromotropic effect (on conductive tissue)

INTEGRATION of regulation in cardiovascular system

The regulation of the heart:

- nn. cardiaci

Cardiac accelerator center – spinal cord, sympathetic ganglia – sympathetic NS

Positive chronotropic effect (on heart rate)

Positive inotropic effect (on contractility)

Positive dromotropic effect (on conductive tissue)

INTEGRATION of regulation in cardiovascular system

Vasomotor centre (regulation for function of vessels)

Medula oblongata

- ✓ *presoric area* (rostral and lateral part – vasoconstriction – increase blood pressure

- ✓ *depresoric area* (medio-caudalis part – vasodilatation, decrease of blood pressure)

INTEGRATION of regulation in cardiovascular system

- Influence by central nervous system
  - cerebral cortex
  - limbic cortex
  - hypothalamus

Regulation of blood pressure

Short - term regulation

- baroreflex

Middle - term regulation

- humorals regulation

- sympathetic - catecholamines
- RAAS
- ADH

Long – term regulation

- kidney regulation

Classification BP values

category	Systolic BP	Diastolic BP
	(mmHg)	(mmHg)
optimal	< 120	< 80
normal	120 – 129	80 – 84
high normal pressure	130 – 139	85 – 89
Hypertension - mild	140 – 159	90 – 99
Hypertension - moderate	160 – 179	100 – 109
Hypertension - severe	≥ 180	≥ 110
Izolated systolic hypertension	≥ 140	< 90

According the Guidelines of European Society of Cardiology 2013

Variability of circulatory parameters

- Heart rate
- Blood pressures – systolic and diastolic

- variability expresses its fluctuation around the average value at certain time intervals (or in various conditions)

Heart Rate Variability (HRV)

- Informs us about the activity of the vagus nerve (tonic activity of n.vagus = vagal tone)
- **Time analysis:**
- from Holter monitoring ECG or 5 - 30min records ECG
- It is basically a statistical evaluation +/-standard deviation
- Disables intervals differing by more than 20% from the average, thus further processed only normal (NN) intervals and evaluated by the standard deviation of all NN sequence for 24h

- **Spectral analysis:**
- Carried out under standard conditions at various maneuvers (supine, standing); evaluated with 300 representative intervals RR / NN /
- Another mathematical processing (Fourier transform) -length RR intervals are converted to cycles in Hz
- The spectrum is divided into several components - low (LF: the sympathetic modulation) and high frequency (HF: vagal modulation)
- People with reduced heart rate variability have a 5 times higher risk of death