Calcium-phosphate balance in childhood

Calcium in the human body:

- Serum – 0,01% complete body system

Ca complete 2,1 – 2,7 mmol/L

30 – 50 % -connected with proteins – albumins, globulins

5-15 % - soluble, not- ionized- complexes phosphate, citrate, bicarbonate;

40 – 60% - ionized (1,12 – 2,23 mmol/l)

- Bones, teeth– 99% - hydroxyapatite
- Liquids extracellular and intracellular

Calcium role in organism

- The threshold of excitability of cells
- - Nerve conduction
- - Muscle excitability
- Muscular contractions – also the normal cardiac contractility
- The intracellular metabolic processes – hormones activity in target cells
- Building block - the skeleton, teeth
- Blood coagulation

- Cofactor intracellular metabolic processes
- Intracellular protein binding of Ca - Calmodulina and troponin C
- As a mediator of signal transduction through the cell membrane - via IP3

Calcium in the body:

- Daily demand - 0.6 - 0.8 g
- Absorbed within approx. 30% in the gut, with help of vitamin D, C, lactose, in an acidic environment.
- Worst absorption: phytate, fiber, oxalic acid, drugs: steroids, thyroxine
- Malabsorption in patients with CF, celiac disease
- Retention in the body- about 10 - 25% (depending on the life-cycle and growth rate) - mainly in trabeculae of the spongy bone
- Newborns- 100 mg/kg mc./24 h, older children-50 mg/kg/24 h –ok.50 % adsorb through gastrointestinal tract
- Sources: milk, cheese, fish, eggs, white beans, dried fruits

Calcium homeostasis:

Ca metabolically active is in:

- body fluids (ionized)
- absorbed from the diet
- bones

- It is maintained in dynamic equilibrium by PTH, vitamin D3 and calcitonin

Ca homestasis

PTH (parathyroid hormone)-> increase Ca in plasma:

- release Ca from the bones
- In the kidneys reduces the excretion of Ca, increases the excretion of PO4
- In the intestine improves the absorption of Ca involving vitamin D3

Calcitonin-> decrease Ca in plasma

- Inhibits the resorption of Ca, PO4 from bones.

Ca homeostasis

Vitamin D3 (skin synthesis, food)

- Increases absorption of Ca and P from the intestine
- Increases bone mineralization.

Synthesis of active vitamin D3 and its proper functioning is impaired in:

- liver disease
- kidney disease
- disorders of absorption
- during anti-epileptic drugs therapy

Phosphorus in the body

- P [2,8 – 4 mg/dl]
- ion intra- and extracellular
- The main component of cell membranes
- Component of nucleic acids, nucleotides, ATP
- Inorganic P - component of the buffer system - the removal of H + through the kidneys

Phosphorus in the body

- Source - food (including pretty much P), it is not observed nutritional deficiencies P
- Mainly milk (36%), meat (20%), eggs (12%)
- The optimum Ca: P ratio of 2: 1
- Intestinal absorption is almost complete, serum levels principally regulated throug renal excretion.

Tetany

The state of excitability of the nervous system resulting due to an abnormal concentration of ions in the extracellular fluid.

- Causes:
  - Hypocalcemia (total Ca <2 mmol / l) - loss of Ca, acute renal failure, vit. D3 deficiency, deficiency / inefficient operation of PTH
  - Hypomagnesemia,
  - Hyperphosphatemia.
  - Alkalosis (hyperventilation)

Tetany

1. Latent: symptoms caused by specific stimuli:

Chvostka sign

Trousseau sign

Ibrahima-Lusta sign

Erba sign

Tetany

2. Overt tetany with large ions disturbances, symptoms appear spontaneously:

- muscle spasms
- seizures (generalized)
- laryngospasm
- bronchospasm
- numbness, paresthesia

Latent tetany:

- **Chvostka sign** –hit by hammer neurological in the area output of n. VII
- **Trousseau sign** – filling the cuff to measure blood pressure for 3 min.
- **Ibrahima- Lusta sign**– hit by hammer neurological overhead sagittal bone (area exit n. peroneal)
- **Erba sign -** irritation of motor nerves galvanic electricity (constant intensity) (less than causing reactions in conditions physiologist.)

Tetany- treatment

- Acute hipokalcemia 1 -2 ml 10% gluconian Ca/kg i.v

very slowly!!!

Chronic hipokalcemia

50 mg/kg 24 h Ca p.o.,

2000 j.m./ 24 h D3

- Hipomagnezemia – 25 %. $MgS0_4$ solution 0,2 ml/kg m.c.
- Hiperfosfatemia - phosphate cessaction in diet (cow milk)

Rickets

Metabolic disorder for children only, caused by a deficiency wit. D3 (originally) and hypocalcemia (secondary) disorders that lead to bone demineralization.

It applies to periods of accelerated growth- low birth weight, 0-2 years of age, puberty.

In adult age is osteomalcia.

Rickets

Vitamin D-related rickets-> Vitamin D deficiency

Vitamin D-dependent rickets- recessive inheritance

Genetic impaired metabolism D3:

- Type 1 (25-Hydroxyvitamin D3 1-alpha-hydroxylase deficiency)
- Type 2 (calcitriol receptor mutation)

Other causes:

- Malabsorption: chronic disease of gastrointestinal tract, liver, biliary tract,
- excess phosphate in the diet
- chronic anticonvulsant therapy.
- Renal osteopenia (chronić renal failure)

Rickets signs:

Bone tenderness

Dental problems

Muscle weakness – delayed psychomotor development

Increased tendency for fractures (easily broken bones), especially greenstick fractures

Skeletal deformity

- Toddlers: Bowed legs and double malleoli
- Older children: Knock-knees (genu valgum) or "windswept knees"
- Cranial deformity (such as skull bossing or delayed fontanelle closure)
- Pelvic deformity
- Pectus carinatum ("pigeon chest")
- Spinal deformity (such as kyphoscoliosis or lumbar lordosis)

Growth disturbance

Hypocalcemia (low level of calcium in the blood)

Tetany (uncontrolled muscle spasms all over the body)

Craniotabes (soft skull)

Costochondral swelling (aka "rickety rosary" or "rachitic rosary")

Harrison's groove

Rickets diagnosis:

- Interview- impaired supply
- Signs

CONFIRMATION:

- X-ray of the wrist
- Markers of Ca / PO 4
- - Decreased amount of PO4 serum
- - Reduced concentration of Ca or normal
- - ALP increased

Rickets treatment

- Vit. D_3 4- 5000 j.m./d for 3 weeks, under ALP control, clinical assesment, after symtoms relief- profilactics doses of Vit. D3 according to child age.

- Symptoms of poisoning vit. D3 (overdose): hypercalcemia, hypercalciuria, dehydration, thirst, loss of appetite, vomiting, constipation, nephrocalcinosis

Rickets prophylaxis:

Proper supply of calcium and vitamin D3

In diet and if necessary supplementation

Ca: 0-0.5 years of age - 400 mg / day, 1 cup milk = 250 mg

0.5 to 1 row. - 600 mg / day, 150 g of yogurt,

1 - 3 years of age - 1000 mg / d, 5 grams of white cheese,

4 - 9 years of age - 800 mg / d, 4-5 pancakes,

10-18 years of age - 1,200 mg / d. 20 dumplings with white cheese, 2 slices of cheese.

-
- vitamin D3: premature - 1000 j.m./dobę,
- full-term newborns, infants - 400 j.m./d,

Vit D3 supplementation

- 0-6 mo 400 IU / 24 h
- 6-12 mo 400-600 IU / 24 h depending on the content vitamin D3 in their diet
- 1-18 years of age 600-1000 IU / 24 h,
  - in September-April, depending on body weight,
  - in whole year if it is not ensured effective skin synthesis of vitamin D in the summer months
- Preterm newborn- 400-800 IU / 24 h to 40 weeks corrected age
- Obese children 1200-2000 IU / 24h (depending on the degree of obesity)
  - in September-April, depending on body weight,
  - the whole year if it is not ensured effective skin synthesis of vitamin D in the summer months

Witamina D: Rekomendacje dawkowania w populacji osób zdrowych oraz w grupach ryzyka deficytów - wytyczne dla Europy Środkowej 2013 r. STANDARDY MEDYCZNE/PEDIATRIA 2013 T. 10 573-578

Vitamin D deficiency

Vitamin D in the 25 (OH) D <20 ng / ml (<50 nmol / l)

The recommended dose therapy (1-3 months):

- Newborns: 1000 IU / day
- Infants aged 1-12 months: 1000-3000 IU / day
- Children and adolescents aged 1-19 years: 3000-5000 IU / day
- Adults: 7000-10000 IU / day (depending on body weight) or
- 50,000 IU / week

Rickets prophylaxis:

- 1-18 years of age. - Additional supply D3 in foods fortified with this vitamin or pharmaceutical preparations
- Vit. D3 1 drop = 500 IU
- Vigantol 1 drop = 670 IU
- Vigantoletten – 1 table a' 500 - 1000 IU
- Tran – 1 caps. a' 35 - 400 IU
- Malabsorption (mainly fats); liver disease, kidney disease, anticonvulsant therapy (phenytoin, phenobarbital)
- - Supplementation of 1,000 IU wit. D3 / day.

Rickets prophylaxis:

- Effective prevention depends on:
- a varied diet containing adequate mounts of calcium, sufficient outdoor activities.
- Important to consider the actual exposure to the sun - dress, UVB filters, air pollution, time spent in the air, people with dark skin.

In the case of isolated symptoms ...

When child has:
fontanel obliterated to quick/ to late
delayed teething,
excessive sweating
It isn't the reason to cahnge the Vit D3 dose..
You should determine the concentration of 250H-D3 and the parameters of the Ca-P.