

Action of calcium binders. Formation of calcium salts in the intestinal tract and the blood circulatory system

Acción de los robadores de calcio. Formación de sales de calcio en el tracto intestinal y en el sistema circulatorio sanguíneo

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Summary

Calcium binders are water-soluble substances whose anionic part can possibly react with calcium cations present in any part of the human body. Some examples of calcium binders are phosphoric, oxalic and phytic acids and their alkaline salts present in many natural foods, in some foods containing additives, and in some medicines. There are also uric and lactic acids that are the result of normal metabolism. The first negative action of calcium binders takes place in the intestinal tract when they react with calcium of dairy food. The latter produces a combination of calcium binder anions with calcium cations, and then an insoluble salt that precipitates as small solid particles that cannot be assimilated and which are eliminated in the faeces. The second negative action of calcium binders takes place when soluble calcium binders are assimilated into the blood circulatory system and get in contact with the free ionized calcium in serum, which gives rise to complexed calcium with inorganic and organic anions. Immediately the free ionized normal level of calcium in blood serum decays, and the parathyroid hormone comes into action (secondary hyperparathyroidism) extracting free ionized calcium from bones (bone resorption). The soluble complexed calcium circulates in the serum through the whole blood circulatory system, and because it is ultrafiltrable, it freely filters through the glomerulus and is excreted in urine. The final result is the formation of the corresponding salts in a metastable state, concentrated near the point where the precipitation of these salts occurs. This special condition is due to the fact that certain proteins are inhibiting the precipitation. In some soft tissues with chronic inflammation, the above-mentioned metastable state is affected because the inhibitory mechanism is blocked, causing the formation of calcium phosphate salts nuclei in the tissue and the build up of calcium phosphate crystals. This triggers causes many serious diseases. Finally, it is suggested that a start can be made on preventing the action of calcium binders by controlling diet, especially by avoiding high intakes of phosphates, oxalates and phytates.

Key words: *calcium binders * osteopenia * osteoporosis * atherosclerosis * nephrosclerosis * urolithiasis * calcinosis * vascular calcification*

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Resumen

Los robadores de calcio son sustancias solubles cuya parte aniónica puede combinarse con cationes de calcio presentes en cualquier lugar del cuerpo humano. Ejemplos de robadores de calcio son los ácidos fosfórico, oxálico, fítico y sus sales alcalinas presentes en muchos alimentos naturales, en alimentos que contienen aditivos y en algunos medicamentos. La primera acción negativa de los robadores de calcio ocurre en el tracto intestinal cuando reaccionan con el calcio contenido en ciertos alimentos (lácteos y sus derivados) produciendo sales insolubles que precipitan como pequeñas partículas que no pueden ser asimiladas y son eliminadas en las heces. La segunda acción negativa de los robadores de calcio tiene lugar cuando, por ser solubles, son asimilados y entran al torrente sanguíneo contactando con el calcio iónico libre del plasma, produciendo complejos de calcio con aniones orgánicos e inorgánicos. Cuando el nivel de calcio iónico libre del plasma sanguíneo decae, la hormona paratiroidea entra en acción (hiperparatiroidismo secundario) extrayendo calcio iónico de los huesos (resorción ósea). Los complejos de calcio circulan por todo el sistema sanguíneo, filtran a través de los glomérulos y parte de las sales de calcio pueden ser excretadas por la orina. La condición de dichos complejos de calcio es un estado metaestable y las sales se concentran cerca del punto de precipitación pero ciertas proteínas de la sangre inhiben la precipitación. En algunos tejidos blandos que presentan una inflamación crónica dicha condición metaestable se afecta porque el mecanismo inhibitorio es bloqueado. Resultado de esto es la formación en el tejido inflamado de núcleos de sales de calcio (fosfatos) que crecen hasta formar cristales de fosfato de calcio. Este es el mecanismo que origina las diferentes calcinosis que causan serias enfermedades. La primera acción preventiva de los fenómenos descritos consiste en el control de la dieta evitando el consumo excesivo de fosfatos, oxalatos y fitatos.

Palabras clave: robadores de calcio * osteopenia * osteoporosis * aterosclerosis * nefroesclerosis * urolitiasis * calcinosis * calcificación vascular

Introduction

With the application of criteria that are basically chemical, normal organic processes in which certain substances, which shall be called calcium binders interfere negatively have been dealt with. Deliberately reference has been made only to diseases that are accepted as related to calcium and its different compositions. It is clear that action on these calcium binders is an important element in the prevention of the diseases in question.

Calcium binders

Water-soluble substances whose anionic part can possibly react with calcium cations present in any part of the human body.

Sources of calcium binders

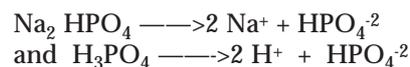
1. Natural food and food with artificial additives that produce anions that react with calcium cations: phosphate, oxalate, phytate etc., during the digestion process.

2. Products of varied origin that could enter the human body, with components containing anions that may combine with calcium cations to form insoluble calcium salts: medicines and drugs are in this category.
3. Some products of normal metabolism like lactate and urate anions, that could combine with calcium cations.

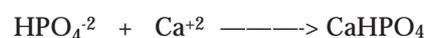
The precipitation of insoluble salts of the different calcium binders mentioned above depends on many factors, especially pH, and anions and proteins concentration.

EXAMPLES:

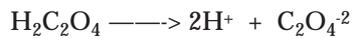
When water-soluble sodium phosphate and phosphoric acid are ionized they produce phosphate anions:



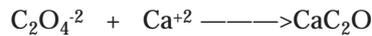
If these phosphate anions find calcium cations in any part of the human body, insoluble calcium phosphate may be produced:



Soluble sodium oxalate and oxalic acid can be ionized to produce oxalate anions:



If the oxalate anions find calcium cations, insoluble calcium oxalate may be produced:



The final result of these chemical reactions depends on reactivities relative concentration, the solubility product, pH, temperature, and especially on complex calcium formations in the serum, which could maintain the solubility of these calcium salts.

The action of calcium binders in the intestinal tract

Normally bone calcification takes place in the first 25 years of life. It needs plentiful calcium in the diet, which is provided by the ingestion of calcium rich food, especially milk and its derivatives. Phosphates, oxalates and phytates are present in certain food and they interfere with the normal assimilation of calcium. This action takes place in the intestinal tract when one or more calcium binders react with the calcium in dairy food, causing calcium binder anions to combine with calcium cations and produce an insoluble salt. These calcium salts are not assimilated because they are insoluble, and normally they are eliminated in the faeces (1).

The action of calcium binders in the blood system

Calcium binders are water-soluble substances, so they can be assimilated and enter the blood circulatory system. In the serum, the amount of free ionic calcium is approximately 4.5 mg/dL. When soluble calcium binders come into contact with the free ionized calcium in serum, complexed calcium is formed (2). This is made up of the combination of calcium and binder ions in a metastable state in concentrations that are near the point where the precipitation of calcium salts occurs. It is thought that a number of proteins inhibit this precipitation (3). Immediately, the free ionized normal level of calcium in blood serum decays, the parathyroid hormone comes into action (secondary hyperparathyroidism) and it extracts free ionized calcium from bones (bone resorption). Complexed calcium in the serum circulates through the whole blood circulatory system, and because it is ultrafiltrable it is freely filtered through the glomerulus and excreted in the urine (4).

COMPLEXED CALCIUM IN THE SERUM: This is the result of free calcium cations combining with binder anions like phosphate and oxalate provided by the diet, and other anions resulting from normal metabolism like lactates, urates, carbonates, citrates and others. The final result is the formation of the corresponding salts in a metastable state, concentrated near the point where the precipitation of these salts occurs. This special condition is due to the fact that certain proteins are inhibiting precipitation. In some soft tissues with chronic inflammation, the above mentioned metastable state is affected because the inhibitory mechanism is blocked, causing calcium phosphate salt nuclei to form in the tissue and calcium phosphate crystals (calcinosis) (5) to build up.

Many serious diseases are linked to abnormal phosphorus and calcium x phosphate levels (6-15) in the serum.

The relative importance of the action of calcium binders

Many factors are involved in determining the importance of the action of calcium binders: a) The number and frequency of food intake containing calcium binders. b) The amount of calcium binders present in each kind of food. c) Daily intake frequency. d) People's age.

First it is necessary to draw up a list of dangerous foods, taking into consideration the factors outlined above. There is no question that soft drinks called "Cola" are at the top of the list. They are one of the unhealthiest foods because they contain an artificial additive, phosphoric acid, which is a powerful calcium binder. "Cola" soft drinks are mainly consumed by children and teenagers. In USA they have a high daily intake that ranges between 500 cc. and 1500 cc. per day, which contains 700 mg/liter of phosphoric acid (Codex Alimentarium). A low intake of calcium-rich food (milk and its derivatives) and a high intake of phosphoric acid, a strong calcium binder, increase the risk of low bone density (osteopenia), and this may cause osteoporosis in adulthood (16-21).

Soluble phosphates occur naturally in normal soil, and vegetables absorb these salts and transfer them to the animals that eat them. As a result, phosphates are present in vegetables and meat. The practice of fertilizing soil with phosphate additives increases the problem, which is an issue that ought to be studied.

Oxalate salts and oxalic acid are calcium binders. They are present in certain vegetables and food like spinach, rhubarb, beets, nuts, chocolate, tea, wheat bran and strawberries. They cause a significant increase in urinary oxalate excretion, increasing the risk of kidney stones (20). Special attention should be paid to the

high levels of soluble oxalates and phytates in certain types of soybean seeds used in some children's food juices (21) (22).

Calcium supplements

It is essential to consume dairy food in the first 25 years of life, and the addition of calcium supplements to milk or other food is recommended. In adulthood, calcium supplements are usually ingested in the form of tablets, normally calcium carbonate. The problem with these tablets is that they act as an anti-acid in the stomach. Some people, especially after middle age, have from insufficient gastric acid secretion that is necessary for normal digestion. Decreasing the gastric acid level by using calcium carbonate causes dangerous interference (23) (24). If excess calcium (alkalosis) is assimilated, it causes hypercalcemia, and if combined with calcium binders, it produces more insoluble calcium salts (25).

The prevention of some diseases caused by calcium binders

DIET CONTROL. In order to practice this, it will be necessary to:

a) Identify a list of substances in the diet that could be considered "calcium binders". b) Identify a list of foods, medicines and other products that contain calcium binders, and to establish their relative amount in each product. c) Have diet control recommended by medical specialists. d) Practice diet control, avoiding foods with high levels of calcium binders. This preventive action should begin with children and teenagers.

MODERATE PHYSICAL EXERCISE. This promotes greater blood circulation and thus may prevent the occurrence of the insoluble salts produced by calcium binders. The intake of safe liquids, especially natural mineral water, is recommended.

BODY MESSAGES: Body massages are recommended for healthy people, and physicians should recommend them for the sick and the elderly.

PREVENTING THE ACTION OF CALCIUM BINDERS: A. Phosphate additives in certain foods, especially in "Cola" soft drinks, should be eliminated. B. Healthy additives should be added to many common foods like milk, juices, flour, salt, etc. Research is necessary in order to identify these healthy additives. C. These healthy additives in tablets or other form should be prescribed to the elderly. D. Organic farm products are recommended because they have low phosphate levels.

Conclusions

The aim of this work is to show that there is an evident connection between calcium binders, especially phosphates, oxalates and phytates, and: 1. The abnormal assimilation of calcium which can cause a secondary osteopenia. 2. The action on "calcium homeostasis", causing secondary hyperparathyroidism and bone resorption (osteoporosis). 3. The formation of complexed calcium in serum, partly fixed in many different soft tissues as calcific deposits, and especially as calcium phosphate crystals that are invariably associated with soft tissue inflammation (calcinosis).

The above-mentioned diseases could be described as "asymptomatic progressive diseases" because it is accepted that they begin in childhood and develop silently, to reach final symptomatic states.

The renal function that normally eliminates the dangerous calcium salts is especially important, but some kidney diseases cause some failure there, which ultimately makes dialysis necessary, increasing the risk of negative cardiovascular events.

Finally, it is suggested that a start can be made on preventing the action of calcium binders by controlling diet, especially by avoiding high intake of phosphates, oxalates and phytates.

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