RESEARCH ON THE VARIATION OF SOME BIVALENT CATIONS IN PATIENTS WITH DISEASES OF THE ORAL CAVITY

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Abstract

The concentration of bivalent cations affects a large number of processes that occur in the oro-maxillary region. A connection has been established between chronic periodontitis, on one side, and the salivary concentration of calcium, magnesium, zinc and copper and the concentration of magnesium in blood, on the other. Patients with suppurations on oro-maxillo-facial area show decreased blood calcium concentration and increased salivary magnesium concentration. In the synthesis of dental enamel, calcium, magnesium, zinc and copper play important roles. Changes in the salivary concentration of bivalent cations are directly involved in some maxillary diseases and in tooth decay.

Keywords: Ca, Cu, Mg, Zn, infections, teeth.

1. INTRODUCTION

Bivalent cations (Calcium, Magnesium, Zinc and Copper and many others) play important and complex roles in the human body, as they maintain the normal structure, function, and proliferation of cells. Variation of intra and extracellular cation concentration is present in the pathogenesis of many human diseases.

The oral cavity is a unique anatomical structure, with a series of characteristics influenced both by the external environment and by the internal one, such as: the direct contact with food, air, the mechanical solicitations of all teeth during mastication, the permanent contact with blood, saliva and microbial commensal flora. Salivary concentration of any type may influence some pathological process occurring in the oral cavity.

Calcium is the most abundant and important mineral present in the human body, the largest amounts – i.e., 99% - being stored in bones and teeth, while the remaining 1% occurs in the liquid and soft tissues. The body needs calcium to maintain strong bones and to carry out several important functions. This cation is involved in the release of presynaptic neuromediators, membrane excitability, neurotransmitter release and muscle contraction, skeletal rigidity and biological signal transduction in the cell membrane. In some diseases of the oral maxillary and parotid gland cancers, the ratio between the salivary concentrations of calcium and magnesium is significantly changed.

Zinc is an essential bivalent cation, normally found in the brain, muscles, bones, kidney, and liver, with the highest concentrations in the prostate and parts of the eye. It has multiple roles, containing in its structure at least 50 metallic enzymes, of which mention should be made of carboxypeptidase, DNA polymerases, RNA polymerases, Zn-Cu superoxide dismutase. Around 300 other enzymes are Zn-dependent. This cation plays a key role in reproduction, for both sexes. Zinc deficiency reduces the maturation of the oocyte, delays and perturbs ovulation. It also modulates the action of some hormones, such as insulin and hypophysargonatotrops, stimulates prolifelation of lymphocytes, macrophages and neutrophils and reduces the peroxidation process. This bivalent cation stimulates prolifelation of fibroblast and synthesis of collagen, while maintaining the acid-base balance of our body.

Copper is an essential micronutrient for all living organisms, as a trace dietary mineral. Adults have 100-150 milligrams (mg) of copper in their body, mostly in muscles and liver. The plasmatic concentrations of copper are about 0.9-1.1 mg/l. Copper is a bivalent cation participating to the
activity of several enzymes, especially those that catalyze the transfer of electrons necessary for cellular respiration, iron oxidation, biosynthesis of neurotransmitters, porphyrin synthesis, etc. Blood copper circulation is mainly related to ceruloplasmin and, to a lower extent, to other plasmatic proteins. Copper is an essential component of CuZn-superoxide dismutase (CuZnSOD). Maintaining the concentration of copper within normal values is important for a normal functioning of the human body.

Magnesium is a bivalent cation participating to many biochemical reactions, such as synthesis of proteins, glucides and lipids, membrane transport of ions, nucleic acid metabolism, synthesis and use of macroergic substances like adenosine triphosphate (ATP) and guanozin triphosphate (GTP). There exist more than 300 magnesium-dependent enzymes. The human body contains about 24-48 g magnesium, most of it (60%) being stored in the bones, as calcium and magnesium salts. Magnesium is predominantly an intracellular cation, only 0.5% being located in the plasma and in the interstitial fluid.

Plasma concentration is magnesium is of 1.2 -1.8 mg/l, being partially linked to albumin. Its membrane forms phospholipid complexes with Na+/K+. It also acts as a physiological antagonist of calcium, being a non-competitive inhibitor of channels.

This cation has a reducing effect on apoptosis, while also reducing the sinaptic release of adrenaline and noradrenaline, for sedative purpose. At the level of the central nervous system, magnesium inhibits the sensitivity of nociceptive stimulation, due to the antagonistic role of its NMDA receptors, and has positive effects in post-operative pain management. Magnesium may act as a relaxation factor for the bronchial smooth muscle and, at the same time, it modulates de inflammatory process, reduces the release of free radicals and, finally, relieves the bronchospasm caused by asthma.

The rigid components of the dento-maxillary apparatus contain high concentrations of calcium and magnesium. The enamel elements contain 37.9% calcium (Ca+2), dentin elements - 25.9%, and the maxilla bone contains 22.5% calcium. The concentration of magnesium (Mg+2) is of 0.42% in the enamel elements, of 0.82% in dentin elements, whereas the maxilla bone contains 0.26% magnesium.

Different cations influence the salivary secretion rate and its composition. The influence of salivary secretion can be determined directly, from the action of salivary glands parenchyma, and indirectly, from the vegetative innervations of these glands. A high magnesium concentration determines a significant reduction of salivary amylase secretion through stimulation with acetylcholine. Stimulation of the parotid gland with Ach increases magnesium saliva concentration. Manea A. et. al. [1] observed no significant difference between the blood concentration of calcium and magnesium in persons with chronic periodontitis - either smokers or non-smokers - comparatively with healthy patients. The mechanisms of chronic and acute inflammatory processes are determined by bivalent cations variations.

Persons suffering with periodontitis have a significantly lower calcium salivary concentration. In both healthy people and those with periodontitis, smoking did not affect the level of salivary calcium. Magnesium salivary concentration is higher in persons with periodontitis, comparatively with the healthy ones. Magnesium salivary concentration is significantly higher in smokers, comparatively with non-smokers. The magnesium:calcium ratio showed high values in persons suffering with periodontitis. It is assumed that magnesium reduces bacterial inflammation, an increased salivary magnesium concentration possibly contributing to reducing periodontal inflammation, as well.

Zinc inhibits the development of certain inflammatory processes. Zinc and copper recorded high values in people with chronic periodontitis. Zinc salivary concentration is higher in smokers than in non-smokers. The level of salivary copper was not influenced by smoking.

Kiss [2] found out that the level of salivary calcium in persons with chronic and aggressive periodontitis (adult smokers and non-smokers) is significantly higher than in non-smokers.

The higher level of salivary calcium concentration was associated to increased bone loss and pocket depth probing. Sutej [3] evidenced
no significant differences in the salivary calcium concentration at patients with periodontitis, either smokers or non-smokers.

Manea A. et. al. [4] established a connection between chronic periodontitis and the salivary concentration of calcium, magnesium, zinc, copper and magnesium in blood. Affected by smoking are salivary calcium and magnesium.

Imbalances between the concentrations of bivalent cations have multiple influences upon dental diseases. The magnesium present in tooth structure has a higher concentration in dentin than in the enamel. [5]

An increased level of magnesium in the tooth, associated with carbohydrate consumption, determines tooth decay. Okazaki M. et al. stated that magnesium increases the solubility of apatite crystals. [6]

Zinc concentration in the dental structures depends on genders, being higher in female subjects. The activity of dental osteoclasts depends on copper, as a result of its stimulating effect. A series of metallic cations is used to treat tooth decay.

2. MALIGNANT TUMOURS
OUT OF ALL HUMAN MALIGNANT TUMORS, THE ONES PRESENT IN THE ORO-MAXILLO-FACIAL AREA REPRESENT ABOUT 1–1.5%.

About 20% - 35% of salivary glands tumors are diagnosed as malignant.[7] Out of these, 63% are located in the parotid glands. [8]

Malignant salivary gland tumors appear as serious diseases, due to their high growth rate.

At present, parotid gland neoplasms show an increased incidence. [9]

Nagler R. and Dayan D. [10] consider that saliva composition is important for the development of malignant tumors, especially for squamous cell carcinoma.

Increasing of Zn2+ concentration is important for reducing the risk of appearance and development of malignant processes. Gradinaru I. et al. [11] observed that, in parotid gland malignant tumours (stages II-III), occurring in adults, the total salivary and serum magnesium concentrations are higher than in healthy persons.

A change has been also observed in the serum total Cu2+ / total Zn2+ ratio, which is lower than in healthy persons. Kopariski Z. et al. [12] found out that, in different forms of cancer, the concentration of serum magnesium is modified.

Some infections in the oro-maxillo-facial area cause major variations of the salivary and plasma concentrations of some cations, especially in cases of bacterial and fungal infections. The ratio between the concentrations of these cations plays an important role, acting upon bacteria and fungi through various mechanisms.

In persons with burning mouth syndrome, the salivary concentration of magnesium is significantly lower, causing, according to the study of Pekiner, an increased predisposition to depression and anxiety. [13]

Nechifor et al. [14] observed that the total salivary serum magnesium concentrations increase in persons with suppurations, comparatively with the healthy ones. Also, in patients with suppurations, a decrease in salivary calcium concentration is registered.

Domej W. et al. [15] found out that the concentration of zinc in blood is reduced in patients with severe infections of the oro-maxillo-facial area.

Prior to the treatment, the patients with oral bacterial suppurations have a increased total salivary magnesium and also a decreased zinc serum concentration. [14]

Low levels of zinc in both blood and tissues adversely affect the immune response.

The action of Histatin 5 is inhibited at high calcium concentrations. In the case of fungal infections, Histatin 5 has a strong fungistatic effect and also fungicidal properties. The action of Histatin 5 is inhibited by the increased salivary calcium concentration. Increasing of the Mg2+/Ca2+ ratio in saliva represents a factor favoring fungal infections. [16]

Some materials used for prosthetic restorations and some drugs contain in their composition bivalent cations, which causes changes in the bivalent cations from the oro-maxillo-facial area.

Determination of the salivary bivalent cations has a major importance for oro-maxillo-facial diseases, as they may be used to determine the predisposition to diseases in the area. [17,18] Saliva is easy to collect. The salivary concentrations
of bivalent cations may favor the emergence and development of different pathological states, but they can also have a negative effect upon them.

References


